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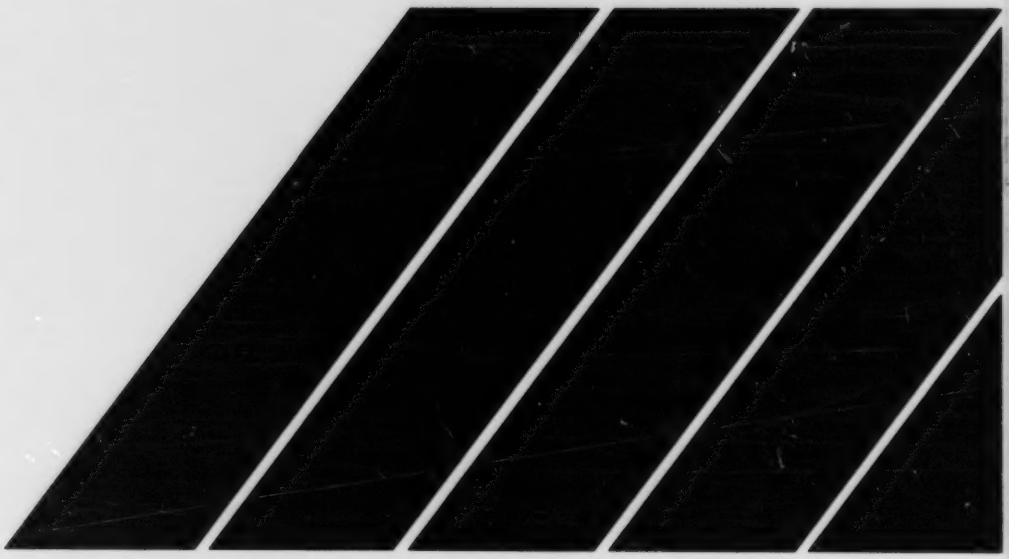
IDENTIFICATION OF SMALL-SCALE HYDRO SITES IN MAINLAND NOVA SCOTIA



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IDENTIFICATION OF SMALL-SCALE HYDRO SITES IN MAINLAND NOVA SCOTIA

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SUMMARY

The report identifies 36 potential small-scale hydro sites between 0.5 and 15 MW using a methodology developed to cost small-scale hydro developments on the basis of limited site data. The project cost is calculated largely from input parameters readily available from large-scale maps. Costs were estimated by means of a desk-top computer program. Although the computer program is capable of estimating project costs within 10 percent of the constructed plant cost, due to the unreliability of the input data in this inventory-type study, computed costs are regarded as having an accuracy of between 25 to 50 percent. On the basis of preliminary benefit-cost data, 10 to 18 of the identified sites appear to be worthy of more consideration. It is recommended that twelve of the most economical sites be studied at the pre-feasibility level and that potential environmental impacts associated with the development of these sites be assessed on a site specific basis.

RÉSUMÉ

Le rapport relève 36 emplacements possibles pour des petites centrales hydro-électriques d'une capacité de 0,5 à 15 MW; la recherche des emplacements utilise une méthodologie mise au point pour déterminer le coût des petites installations hydro-électriques à partir d'une quantité limitée de données sur l'emplacement. Le coût du projet est calculé en grande partie au moyen de paramètres disponibles sur des cartes à grande échelle. Les coûts sont estimés à l'aide d'un ordinateur de bureau. Bien que le programme machine puisse évaluer le coût du projet à 10 % près du coût réel de l'usine construite, on estime que la précision des coûts calculés se situe entre 25 % et 50 %, étant donné le manque de fiabilité des données d'entrée de cette étude de type inventaire. Selon les données coûts-avantages provisoires, entre 10 et 18 des emplacements identifiés mériteraient d'être examinés de façon plus détaillée. Il est recommandé d'entreprendre une étude préalable des 12 emplacements les plus économiques et d'en évaluer les répercussions environnementales possibles associées à leur mise en valeur.

1.0 INTRODUCTION

Le rapport relève des emplacements dans la partie continentale de la Nouvelle-Écosse où il serait possible d'installer de petites (moins de 20 MW) centrales hydro-électriques dont la capacité installée serait supérieure à 500 KW. Il fournit une estimation provisoire des coûts pour chaque emplacement. En outre, il présente un bref historique des cinq petites centrales hydro-électriques qui sont actuellement exploitées en Nouvelle-Écosse et dont la capacité varie de 5 à 500 KW.

Le rapport complète d'autres données recueillies antérieurement sur les emplacements des petites centrales hydro-électriques en Nouvelle-Écosse (Montreal Engineering, 1976, 1978). En 1976, 11 bassins versants identifiés par la Nova Scotia Power Corporation (NSPC) ont été examinés afin d'en déterminer les ressources hydro-électriques possibles. En 1978, plusieurs petits projets hydro-électriques identifiés par la NSPC ont été examinés. À l'exception des installations de Fall River et de Factorydale, qui font partie des cas concrets, aucune installation hydro-électrique désaffectée n'a été incluse dans l'inventaire.

2.0 MÉTHODOLOGIE

La méthode utilisée pour trouver les emplacements est similaire à celle utilisée dans l'inventaire des emplacements de petites centrales hydro-électriques au Nouveau-Brunswick et dans l'Île-du-Prince-Édouard (Monenco, 1984). Les emplacements ont été détectés à l'aide des cartes existantes. Des cartes à une échelle de 1/50 000, de 1/10 000 et d'autres à plus petite échelle ont été utilisées pour établir la charge hydraulique et d'autres éléments physiographiques. Les emplacements ont d'abord été triés en fonction de la charge hydraulique et de l'aire de drainage nécessaires pour satisfaire aux objectifs de l'étude. Sont exclues, les rivières ayant déjà des centrales hydro-électriques et des installations d'approvisionnement en eau et dont les bassins versants se trouvent dans des parcs nationaux et provinciaux.

L'étude n'a pas tenu compte des répercussions environnementales pour chaque emplacement, bien que ceux ayant des contraintes environnementales connues aient été notés et qu'un bref résumé environnemental ait été présenté.

L'ordre de grandeur des coûts est estimé à l'aide d'un programme machine, d'un ordinateur IBM PC et d'autres ordinateurs compatibles. Le programme est une amélioration du programme SHYDRO, que la Monenco Limited a mis au point en 1984 à l'aide d'un grand ordinateur DEC 20, et qui permettait d'établir le coût de petites centrales hydro-électriques à partir d'une quantité limitée de données sur les emplacements. Les seules données d'entrée sont celles qui sont facilement disponibles sur les cartes à grande échelle, ce qui permet d'économiser le coût des visites et des levés sur le terrain.

Les coûts suivants ne sont pas inclus dans le devis du projet:

1. l'achat du terrain;

2. l'essartement;

3. le déplacement des routes, des chemins de fer, des lignes à haute tension, des ponts, rendu nécessaire par la mise en eau du réservoir, etc.; et

4. le déplacement ou l'achat des bâtiments touchés par la mise en eau du réservoir.

1.0 INTRODUCTION

This report identifies potential small-scale (i.e. less than 20 MW) hydro sites in mainland Nova Scotia capable of supporting an installed capacity in excess of 500 kW. A preliminary cost estimate is provided for each site. In addition, brief case histories are provided on five existing small-scale hydroelectric developments in Nova Scotia, ranging in size from 5 to 500 kW.

The present study augments previous data collected on small hydro sites in Nova Scotia (Montreal Engineering, 1976, 1978). In 1976, eleven specific river basins identified by the Nova Scotia Power Corporation (NSPC), were investigated to identify potential hydroelectric resources. In 1978, several specific small hydro projects identified by the NSPC were studied. With the exception of the Fall River and Factorydale developments, described in the case histories, no decommissioned hydro sites are included in the current inventory.

2.0 METHODOLOGY

The approach used for identifying potential hydroelectric sites was similar to that utilized in the Monenco inventory of small-scale hydroelectric sites in New Brunswick and Prince Edward Island (Monenco 1984). Potential sites were identified from available mapping. Maps of 1:50,000 scale were supplemented by 1:10,000 and smaller scale maps to identify the head and other physiographic features. Sites were initially screened on the basis of the combination of head and drainage area necessary to meet the study objectives. The inventory excluded rivers with existing hydroelectric and active water supply developments and watersheds in National and Provincial Parks.

Sites were not screened for environmental impacts, although sites with known environmental constraints have been noted and a brief environmental overview is presented.

Order of magnitude costs were estimated using a computer program for IBM PC and compatibles. The program is a further development of the SHYDRO program originally developed on a DEC 20 mainframe computer by Monenco Limited in 1984 for costing small-scale hydro developments on the basis of limited site data. Input data have been restricted to that which is readily available from large-scale maps, thereby avoiding the cost of site visits and surveys.

The following costs are not included in the project cost estimate:

1. land purchase;
2. land clearing;
3. relocation of roads, railways, powerlines, bridges, due to reservoir flooding, etc.; and,
4. relocation or purchase of buildings affected by reservoir flooding.

2.1 SHYDRO-PC INPUT

The 17 site specific parameters required are as follows:

PARAMETER	COMMENTS
1. NAME OF WATERSHED (for future identification)	Name of watershed
2. SITE NUMBER (for future identification)	Site number
3. RATED HEAD	Height between reservoir and tail-water obtained from best available available mapping less hydraulic losses

PARAMETER	COMMENTS
4. DESIGN FLOW (in cubic metres per second)	See footnote 1
5. PENSTOCK LENGTH (in metres)	Obtain from best available mapping
6. ACCESS ROAD LENGTH (in kilometres)	Obtain from best available mapping
7. TRANSMISSION LINE LENGTH (in kilometres)	Obtain from best available mapping
8. DAM HEIGHT (to spillway crest in metres)	Maximum dam height to spillway crest
9. DAM LENGTH (abutment to abutment in metres)	Obtain from best available mapping
10. DISTANCE TO TOWN (in kilometres)	Obtain from best available mapping
11. DISTANCE TO CONCRETE PLANT (in kilometres)	Obtain from best available mapping
12. FLOOD FLOW (in cubic metres per second)	See footnote 2 (next page)
13. INSTALLED CAPACITY (megawatts)	Calculated for each site from rated head and design flow losses

1. The design flow was selected to be 1.5 times the mean annual flow at the site. A Review of the regional flow duration curves showed that a maximum turbine flow ratio of 1.5 would allow up to 75% of the annual flow at a site to be passed through the turbine for a run-of-river installation, resulting in an average plant capacity factor of 0.5. The mean annual flow at the site was determined from the iso-runoff map (Acres, 1985) and the drainage area at the site.

PARAMETER	COMMENTS
14. NUMBER OF UNITS	
15. USEFUL TURBINE FLOW RATIO (as a fraction of mean flow at the site)	0.75 (see footnote 1)
16. MAXIMUM TURBINE FLOW RATIO (as a fraction of mean flow at the site)	1.5 (see footnote 1)
17. FISHWAY REQUIRED (yes or no)	User determines if required. Designate as 1.00 if required, 0.00 if not

The program also requires input of unit prices and other cost data. Most of these are expressed as equations having an exponential form as follows:

$Cost = KV^X$

where K is an input constant

V is the quantity of work

X is an exponential with a value less than unity

The cost parameter data are as follows:

---

2. For inventory of a large number of sites, the flood flow was estimated on the basis of the formula Q = 250 A 3/4, where A is the drainage area in square miles (Montreal Engineering, 1969). The flow in cfs was then changed to m^3/s. This flow was found to envelope the estimated 100 year return period flood (Acres, 1985).

PARAMETER	COMMENTS
1) TIMBER CRIB ($/cubic metre)	Unit price based on quantity of 800 cubic metres
2) CONCRETE DAM ($/cubic metre)	Unit price for mass concrete based on quantity of 1000 cubic metres, incl. formwork and reinforcing
3) SPILLWAY CONCRETE ($/cubic metre)	Unit price for structural concrete, incl. formwork and reinforcing
4) EXCAVATION/BACKFILL ($/cubic metre)	Based on quantity of 5000 cubic metres
5) ACCESS ROAD ($/kilogram)	Based on length of 5 km.
6) FISHWAY ($/m OF DAM HT)	
7) INTEREST RATE (%)	
8) O & M COST (% of capital cost per annum)	Expressed as percentage of capital cost
9) REVENUE OR VALUE OF POWER ($/megawatt hour)	

The values used for site cost parameters are as follows:

1) TIMBER CRIB ($/cubic metre)	300.00	
2) CONCRETE DAM ($/cubic metre)	400.00	
3) SPILLWAY CONCRETE ($/cubic metre)	500.00	
4) EXCAVATION/BACKFILL	10.00	
5) ACCESS ROAD ($/KM.)	60,000.00	
6) FISHWAY ($/M OF DAM HT)	41,000.00	
7) INTEREST RATE (%)	10.00	
8) O & M COST (% OF CAPITAL COST PER ANNUM)	1.50	
9) REVENUE ($/MWH)	100.00	(EQUIVALENT TO 10 CENTS/KWH)
10) TOTAL AVAILABLE TURBINE FLOW	0.75	
11) DESIGN FLOW RATIO	1.50	
12) FISHWAY REQUIRED (Y/N)?	1.00	(INDICATING YES)

2.2 SHYDRO-PC OUTPUT

.1 Calculated Data

The SHYDRO Program calculates the Penstock Diameter and Capacity Factor.

Within the program there is a routine for calculation of the penstock diameter using a formula developed by Fahlbush (1982), based on the flow and developed head.

The capacity factor is calculated by dividing the useful turbine flow ratio by the maximum flow ratio. The capacity factor is used to calculate the energy generated for economic analysis purposes.

.2 Information Statements

The output format is standardized with the exception of four information statements described below. These are included in the printout when applicable.

1. "NOTE-TRANSMISSION LINE LENGTH EXCEEDS 10 x MW"

   This statements indicates to the program user that it may not be technically feasible to construct the transmission line for the estimated cost. The transmission voltage may be too low for the length of line required.

2. "NOTE-PENSTOCK LENGTH EXCEEDS 20 x H"

   This statement warns that the penstock input length is in excess of 20 times the rated head. Beyond this length regulation of the unit becomes difficult and allowance should be made for a surge tank, which is not included in the program estimate.

3. "NOTE-THE FOLLOWING COSTS MAY NOT BE REPRESENTATIVE FOR SITES UNDER 250 kW "

   This statement indicates that the costing methodology is based on data from sites larger than 250 kW and may not be representative of smaller sites where alternate equipment and materials, owner labour, and reduced access requirements may substantially reduce cost.

4. "NOTE-SUBSTATION COST INCLUDED IN EQUIPMENT SUPPLY COST"

   This statement indicates that the cost of the substation is included with the powerhouse cost for sites with capacities over 5 MW.

.3 Calculated Costs

The Program uses the above input data to calculate the following:

LEAST COST

The program calculates the "least cost", based on a simple methodology which was developed by a statistical analysis of cost data obtained for over 170 projects ("Hydropower Cost Estimates), by J.L. Gordon, Water Power, November, 1983). The "least cost" formula has recently been updated to include the analysis of approximately 20 mini/micro sites in rural communities.

The formula represents the probable minimum cost of development for a small-scale hydro project with preferred site characteristics. The formula is intended primarily for projects under 10 MW capacity and does not include transmission costs or interest during construction. The formula cannot, at this time, be used with confidence for estimation of the capital cost of development.

The "least cost" formula is used as a check of the SHYDRO program cost. If the latter was found to be lower, then the site-specific input parameters must be checked to determine the reason for the apparent lower cost.

The Program then calculates the costs of the following basic project components.

DAM

Calculates cost of three alternative dams, earthfill, concrete and timber crib; prints out the lowest cost alternative (dam plus spillway). If concrete or timber crib is selected, the spillway is incorporated in the dam. If earthfill is selected, program calculates cost of separate spillway. Dam cost is a function of dam length and height to spillway crest.

In addition, the type of dam selected by the program is listed under the dam heading in the Cost Estimate Summary. The alternate types of dam/spillway combinations which may be listed are as follows:

Dam	Spillway
"(EARTHFILL)"	$ COST
"(TIMBER)"	"SEE DAM"
"(CONCRETE)"	"SEE DAM"

SPILLWAY

Calculates cost as function of dam height and flood flow over a weir spillway within a rock abutment, with a spillway chute in cut.

INTAKE

Calculates cost of a concrete intake structure, with an intake for each unit. Intake equipped with usual trash-racks, gate, and air vent. Cost is a function of number of units, and flow per unit.

PENSTOCK

Calculates cost of three alternative penstocks - polyethlene, fiberglass and steel; prints out type and cost of lowest cost alternative. Cost is a function of head, penstock length and number of units.

UNWATERING

Calculates cost of unwatering dam site to build dam. Cost depends on type of dam and diversion flood flow. The diversion flow is estimated within the program to be 50 percent of the flood flow.

POWERHOUSE CIVIL WORKS

Calculates cost of powerhouse, with cost depending on number of units, installed capacity and rated head.

EQUIPMENT SUPPLY

Calculates overall cost of powerhouse equipment based on number of units, capacity and head.

EQUIPMENT ERECTION

Calculates cost to install all powerhouse equipment as a percentage of equipment cost.

ACCESS ROAD

Calculates cost of access road as a function of length.

TRANSMISSION LINE AND SUBSTATION

Calculates cost as a function of total unit capacity and distance.

FISHWAY

Calculates cost as a function of dam height.

CONTRACTOR'S OVERHEAD

The estimate for contractor's overhead cost is made up of two components.

The first component is 10 percent on all items except equipment and the transmission line. This component represents the contractor's markup and is applied to the following costs:

- dam unwatering
- intake
- penstock erection
- penstock earthwork
- powerhouse civil works
- equipment erection
- access road
- fishway (if required)

The second component reflects the remoteness of the site and the cost of transportation and travel. The upper limit of this component is set at 40 percent of the cost of the following work:

- dam unwatering
- intake
- spillway
- penstock earthwork
- powerhouse civil
- access road
- fishway (if required)

Input data used to calculate this component are the distance to the nearest concrete plant and the distance to the nearest town.

ENGINEERING AND OWNER'S COST

An allowance for the design, construction supervision and management costs. Calculated as a function of project cost.

INTEREST DURING CONSTRUCTION

Cost based on a function of project cost, length of construction, and interest rate.

The SHYDRO-PC Program accumulates the above costs and calculates the following:

PROJECT COST

The Program has been tested against projects greater than 250 kW and has been found to estimate the project cost within 10 percent of the constructed plant cost. However, due to the unreliability of input data, the computed costs can only be regarded as having an accuracy in the region of 25 to 50 percent. For sites under 250 kW the "least cost" may be more representative of actual project cost.

COST PER kW

The Program calculates the cost per installed kilowatt from the project cost and installed capacity.

ANNUAL COST

Cost calculated on basis of amortized cost at given interest rate and estimated operating and maintenance costs.

ANNUAL BENEFIT

Cost calculated on basis of installed capacity, capacity factor, and value of generated power.

BENEFIT/COST RATIO

Finally, the program calculates a simple benefit/cost ratio based on the above values. A site with a benefit/cost ratio in excess of 0.85 may be worthy of more detailed evaluation.

2.3 CASE STUDIES

Five existing small-scale developments in Nova Scotia are described from interviews and a review of available information. Data on costs, project construction, design, maintenance, and electrical production are summarized for each case study. The case studies are presented in Appendix 1.

3.0 REGULATORY REQUIREMENTS

Before development of a small hydro facility can proceed, a Water Rights License and a Watercourse Alteration Permit must be obtained from the Nova Scotia Department of the Environment. Both can be obtained by completing an "Application for Permit or License Under the Water Act" which can be obtained from the following Nova Scotia Department of Environment Offices:

P.O. Box 2107
Halifax, Nova Scotia
B3J 3B7
Telephone: 425-5300

P.O. Box 714
Sydney, Nova Scotia
B1P 6H7
Telephone: 539-2790

The Nova Scotia Department of the Environment will notify appropriate federal and provincial government departments based on the nature of the potential impacts associated with the hydro development. More information may be required to support an application for dam construction, including dam and spillway specifications and engineering scale drawings.

The Canada Fisheries Act is the most frequently used federal piece of legislation in considering applications. Thus, it is often worthwhile to contact the Fish Habitat Protection Section, Fisheries Research Branch of the Federal Department of Fisheries and Oceans to see if special requirements for fish protection are required. For example, it is the present policy of Fisheries and Oceans Canada to provide functional plans to any hydroelectric developer for fishways at dams whenever these are required.

All projects initiated by the Federal government, or those involving Federal funding, Federal property, or Federal jurisdiction are subject to the Environmental Assessment and Review Process (EARP). The initiator of a project is responsible for preparing an environmental assessment of the likely effects of a proposed development, using guidelines prepared by Environment Canada. Those projects which are considered significant are subject to an individual review by separate Environment Assessment Panels, with a permanent Chairman from Environment Canada. Each Panel issues guidelines for the preparation of an environmental impact statement by the initiator or proponent of the project. Both the guidelines and the EIS are made available to the public, and public meetings are arranged to obtain input from interested parties. The Panel then prepares a report to the Minister of Environment based on a review of the EIS, public response, and any other information it requires. The Minister of Environment and the Minister of the initiating department decide on the action to be taken on the report submitted by the Panel. Although not enforceable legally, each Federal department involved is responsible for implementing EARP, while the Minister of Environment is responsible for evaluating the performance of the process.

4.0 ENVIRONMENTAL CONSTRAINTS

A thorough review of the ecological effects of small-scale hydro development in New Brunswick and Prince Edward Island was undertaken by Monenco in 1984. The study found that, in general, environmental issues associated with small-scale development differed only in scale from those of conventional hydro development. In other words, in terms of potential environmental impact, there is nothing necessarily unique about hydro development below 20 megawatts. Thus an initial environmental evaluation of small-scale hydro must consider the same points of potential concern relative to the physical and operational parameters of the specific development, although in practice many potential issues can often be quickly eliminated as irrelevant or inconsequential.

For a thorough discussion of potential environmental effects of small-scale hydro development in Atlantic Canada, the reader is referred to Monenco (1984).

4.1 ENVIRONMENTAL OVERVIEW

Despite the number of potential issues, it is clear that impacts associated with conserving anadromous fish (particularly Atlantic salmon) is the most important environmental consideration. A life history that depends on upstream and downstream migrations makes anadromous species particularly vulnerable to hydroelectric development. Mitigative measures are available relative to upstream and downstream passage of anadromous fish through most small-scale hydro developments. Factors such as the loss of spawning habitat and the maintenance of suitable downstream flows can also be balanced or even enhanced as long as the project is able to bear the costs involved in such mitigative measures. It must, however, be realized that despite the technical feasibility of maintaining anadromous fish stocks relative to a specific small-scale hydro development, the concerns which Atlantic salmon foster with interest groups and the general public may, from a practical standpoint, preclude developments on popular salmon streams, even in the event that the development is economically attractive and can support necessary mitigative measures.

Although sites were not screened for environmental impact, development on the St. Mary's River would meet with serious opposition from both Fisheries and Oceans Canada and the Nova Scotia Salmon Federation. Previous consideration for hydro development on the Gold River was met by strong opposition from salmon anglers and Fisheries and Ocean Canada.

4.2 SUMMARY OF MITIGATIVE MEASURES

The key to the identification and implementation of effective mitigative measures is a collaborative approach between hydroelectric developers and natural resource managers. This collaboration should occur early in the planning process and non-optimal levels of attainment of each separate and conflicting set of goals may have to be accepted. In many cases, multiple-objective solutions will be identifiable and mitigation accomplished at a cost the project can bear economically.

Table 4-1 provides a summary of the major potential impacts of small-scale hydro development and the appropriate mitigative measures that are available to eliminate or lessen the impact.

5.0 SITE COST DATA

The locations of the sites investigated in the present study, along with those from the 1976 and 1978 Montreal Engineering studies, are shown in Plate 5-1. A total of 42 sites are identified and 36 of these sites have been evaluated in the present study.

Detailed information for each identified site, including a cost estimate summary, is provided in Appendix 2. The location, installed capacity and cost per kilowatt for each site are summarized in Table 5-1. The sites are listed in decreasing order of their benefit/cost ratio.

TABLE 4-1

Summary of Major Impacts
Associated with Small-Scale Hydro Development and Mitigative Measures [1]

1.	Altered Stream Flow	- operate as run-of-river - release appropriate flows
2.	Blocking of Upstream Fish Passage	- provide fishways - collect and truck upstream - temporary opening of small dams
3.	Interference with Downstream Fish Passage	- spillway releases during downstream migration - choice of turbine - operate turbines for maximum efficiency - submerge turbine intake - screen turbine intake - limit spillway height to 30 metres
4.	Loss of Riparian and Terrestrial Habitats	- limit extent of reservoir - monetary compensation - harvest timber prior to flooding - relocate roads, dwellings and archaeological artifacts - route selection for transmission line
5.	Loss of Lotic Habitat	- replace lost fish production with artificial propagation
6.	Water Level Fluctuations in Reservoir	- limit extent and frequency of drawdowns
7.	Dredging	- land disposal of material - choice of equipment - timing of dredging
8.	Water Quality Changes	- operate as run-of-river - reservoir preparation - depth of outlet

1 From Monenco (1984).

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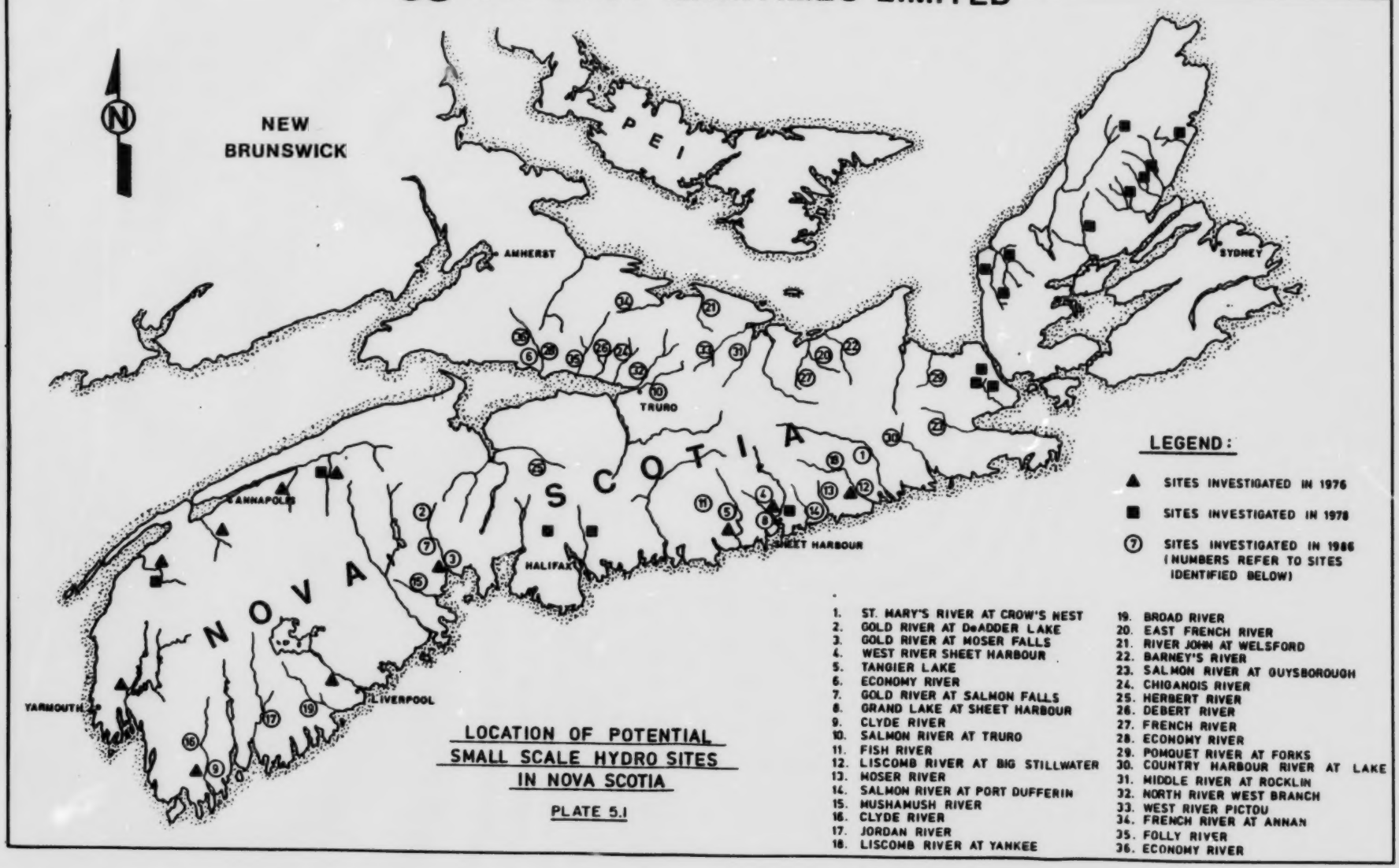


LOCATION OF POTENTIAL SMALL SCALE HYDRO SITES IN NOVA SCOTIA

PLATE 5.1

TABLE 5-1

Location, Installed Capacity and Cost per Kilowatt of Identified Sites

Site No.	Watershed	Location	Reference Maps 1:50,000	Approximate Coordinates North	East	Installed Capacity (MW)	Cost/kw($)	Benefit/ Cost
1	St. Mary's River	Crow's Nest	11E/1	5009100	576100	15.200	1485	2.57
2	Gold River	DeAdder Lake	21A/9	4935000	393000	6.100	1679	2.27
3	Gold River	Moser Falls	21A/9	4954800	385000	6.200	2044	1.86
4	West River	Sheet Harbour	11D/15	4975000	536000	3.560	2088	1.83
5	Tangier Lake		11D/15	4966400	521200	4.500	2378	1.60
6	Economy River		11E/5	5033200	428000	1.200	2706	1.41
7	Gold River	Salmon Falls	21A/9	4946200	384400	4.200	2803	1.36
8	Grand Lake	Sheet Harbour	11D/15	4971800	534700	.597	3001	1.27
9	Clyde River		20P/11	4838000	299800	3.170	3089	1.23
10	Salmon River	Truro	11E/6	5027000	490000	3.200	3095	1.23
11	Fish River		11D/15	4971000	500800	3.220	3361	1.13
12	Liscomb River	Big Stillwater	11E/1	4987500	570000	6.620	3583	1.06
13	Moser River		11E/1	4984300	557900	2.340	3676	1.04
14	Salmon River	Port Dufferin	11D/16	4975200	548700	1.700	3869	0.98
15	Mushamush River		21A/8	4925000	386000	1.600	3961	0.96
16	Clyde River		20P/12	4845600	299750	3.230	4041	0.94
17	Jordon River		20P/14	4863500	320000	1.500	4420	0.86
18	Liscomb River	Yankee	11E/1	4964000	566500	4.200	4466	0.85
19	Broad River		20P/15	4870000	350000	1.200	4524	0.84
20	East French River		11E/9	5037100	548700	1.160	4584	0.83
21	River John	Welsford	11E/11E	5058200	496000	2.220	4610	0.83
22	Barney's River		11E/9	5051500	556000	.850	5123	0.74
23	Salmon River	Guysborough	11F/5	5024800	603000	1.660	5791	0.66
24	Chiganois River		11E/11,11E/6	5039500	472900	1.330	5850	0.65
25	Herbert River		11D/13,11E/4	4985500	435000	1.600	6306	0.60
26	Debert River		11E/11,11E/6	5039000	465400	.940	6556	0.58
27	French River		11E/9	5050600	540000	.650	7527	0.51
28	Economy River		11E/5	5033200	428000	2.350	7688	0.50
29	Pomquet River	Forks	11F/12	5048000	592200	.570	7914	0.48
30	Country Harbour River	Lake	11F/5	5016700	585400	.430	8316	0.46
31	Middle River	Rocklin	11E/7	5372000	518200	.540	8435	0.45
32	North River	West Branch	11E/11	5039500	479000	.370	10125	0.38
33	West River Pictou		11E/10	5041200	508200	.610	10564	0.36
34	French River	Annan	11E/11	5055000	472000	.430	13035	0.29
35	Folly River		11E/5	5037000	459000	1.000	13430	0.28
36	Economy River		11E/5	5033200	428000	2.740	13654	0.28

The following brief comments pertain to the top ten sites listed in Table 5-1. Site maps showing the locations of the development of the top ten sites are included in the relevant site summaries in Appendix 2.

5.1 ST. MARY'S RIVER, CROW'S NEST

St. Mary's River has a drainage area of 1474 square kilometres, and provides, no doubt, several opportunities for development. However, the St. Mary's is an important salmon river in Nova Scotia and considerable opposition would be expected to development. For this initial investigation, a damsite has been selected between Waternish and Crowsnest, in the lower reaches of the St. Mary's. This site would have a 27 m high dam, with a powerhouse located adjacent to the dam.

5.2 GOLD RIVER, DeADDER LAKE

The Gold River watershed has been considered for power development in the past. Reference is made to one potential site in the Atlantic Development Board study, Volume IV - Nova Scotia, Book IV, Gold River, page 2-1. The ADB report discusses a potential site between Harris Lake and the confluence of Mill Brook, where an earth dam 150 m long, with a tailrace channel 240 m long, could develop a head of 60 m and utilize water from a 120 square kilometres drainage area. A review of available topographic maps for this site suggest that a preferable development would have a total head of 45 m and consist of a 17 m high dam at the outlet of DeAdder Lake, with 1.6 km long penstock to a powerhouse located near New Ross.

5.3 GOLD RIVER, MOSER FALLS

A second site on the Gold River was identified during the 1976 MECo study for the Nova Scotia Power Corporation. The site, referred to as Moser Falls, requires a 15 m high dam and a long penstock to the estruary. The total developed head would be 45.7 m.

5.4 WEST RIVER, SHEET HARBOUR

All the streams and rivers in the West Sheet Harbour watershed appear to run relatively parallel of the headwaters. Two main tributaries exist - the Killag River and the West River Sheet Harbour. The watershed is relatively flat and the only development opportunity appears to be downstream of the confluence of the Killag and the West River Sheet Harbour. There is a relatively steep-sided gorge below the confluence and between Sheet Harbour Lake. There is a small existing dam at the outlet of Sheet Harbour Lake. The 50' contour crosses in the area of the pulp mill, adjacent to the northwest arm estuary. It appears that the potential scheme of development would be to raise the Sheet Harbour Lake outlet dam and construct a short penstock to the tidal northwest arm, developing a head of 31 m.

5.5 TANGIER LAKE

The Tangier watershed was also studied during the 1976 MECo study. Proposed development consists of a powerhouse, located at Tangier Lake, and a dam located upstream between Tangier Lake and O'Brien Lake. The study identifies the ultimate development of the Tangier River as consisting of a diversion of Scraggy Lake in the headwaters. The diversion would consist of a dam and a diversion canal towards Hilchy Lake. The present costing of this site includes only the drainage area proper. A review of the topographic maps susggest that a dam at the outlet of Tangier Lake with the powerhouse located at Tangier Harbour could be a possible development site.

5.6 ECONOMY RIVER

The Economy River drains the Cobequid Mountains to the south. A possible site on the Economy River has been identified, which would allow construction of a moderately long penstock and a low dam, or a high dam with a short penstock, to develop about 100 m of head. For example, a 75 m

high dam downstream of Newton Lake would result in 106 m of developed head with a short penstock. A 40 m high dam in the same area, with a penstock approximately 1 km long, would result in a developed head of 91 m. The low dam alternative was subsequently chosen resulting in a 3 m high dam, a 650 m long penstock and 45 m of developed head.

5.7 GOLD RIVER, SALMON FALLS

A third site on the Gold River was identified during the 1976 MECo study and was referred to as the Salmon Falls site. Development at this site would flood out several bridges, roads and houses at Lossen and Darling Lakes, which are just downstream of New Ross.

5.8 GRAND LAKE, SHEET HARBOUR

This is a relatively small watershed, located between the West River Sheet Harbour and the Tangier River watershed. The drainage area consists of a large lake at elevation approximately 30.5 m. Proposed development would be a small dam at the outlet of Grand Lake, probably in the order of 4.5 m high, and a penstock to the northwest arm. A second possible development near the mouth, with 30 m high dam was also costed, but was less economical.

5.9 CLYDE RIVER

Two sites on Clyde River were identified during the MECo 1976 study. The lowermost of these sites proved more economical during the present cost analysis. The development would consist of a 10 m high dam with a powerhouse located immediately downstream.

5.10 SALMON RIVER, TRURO

This Salmon River enters Cobequid Bay at Truro. The upper watershed consists of three main streams - Salmon River proper, Black River, and Calvary River. Any potential development would have to be located downstream of the confluence of the main Salmon River and Black River. A potential site, consisting of an approximately 24 m high dam, developing a total of 30.5 m of head, has been identified at Union. The raising of the water level at Union to elevation 76 m would result in minor flooding of a short section of road and a bridge upstream on Salmon River.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Although 36 potential small-scale hydro sites were identified that met the study criteria in terms of installed capacity, the estimated costs relative to the power produced varied considerably. For example, the benefit/cost ratio and the cost per installed kilowatt varied by a factor of nine between the most and least economical sites (Table 5-1). On the basis of a value of 10 cents/kW hour for generated power, fourteen sites have a benefit/cost ratio equal to or greater than one. It should be remembered, however, that cost of land and the costs associated with the relocation of roads, bridges, railways, buildings, etc., have not been included in the project cost. On the basis of this preliminary benefit/cost data, 10 to 18 of the identified sites appear to be worthy of more consideration.

Prior to examining specific sites in more detail, however, we recommend a synthesis of the MECo 1976 and 1978 studies with the present study to obtain a common assessment of potential Nova Scotia sites. Then the top dozen or so sites should be studied in more detail, including site visits and the development of preferred site layouts to the pre-feasibility level of detail. Included in the pre-feasibility studies should be consideration of site specific envirnomental effects. Because of the identified conflict with anadromous fish conservation, the fisheries concerns should be specifically identified with a view to developing and costing appropriate mitigative measures.

REFERENCES

Acres International Limited. 1985. Hydrologic design methodologies for small-scale hydro at ungauged sites - Phase II. A report to the Inland Waters Directorate, Atlantic Region. 20 p.

Fahlbusch, F. 1982. Power tunnels and penstocks: the economics re-examined. Water Power & Dam Construction, June 1982. pp. 13-15.

Gordon, J.L. 1981. Medium head hydro powerhouse concrete volumes. Proc. ASCE, J. Energy Div., Vol. 107:237-254.

Monenco Limited. 1984. Identification of environmentally compatible small-scale hydroelectric potential in Atlantic Canada - Phase I New Brunswick and Prince Edward Island. A report to Environment Canada, Energy, Mines and Resources Canada, and Supply and Services, Canada. January 1984.

Montreal Engineering Company, Limited. 1969. Maritime Provinces Water Resources Study. A report for the Atlantic Development Board. January 1969.

Montreal Engineering Company, Limited. 1976. Survey of hydroelectric resources in Nova Scotia. A report for the Nova Scotia Power Corporation. March 1976.

Montreal Engineering Company, Limited. 1978. Nova Scotia small hydro study. A report for the Nova Scotia Power Corporation. December 1978.

APPENDIX I

SMALL HYDRO CASE STUDIES

BLACK RIVER DEVELOPMENT

1. **Project Summary**

Name:	Black River Development
Owner:	Mr. Neal Livingston Mabou Inverness County, Nova Scotia B0E 1X0 Tel: (902) 258-3354
Capacity:	5 kW
Gross Head:	30.5 m
Dam:	Concrete structure 0.6 m high by 5.5 m long, with a center portion 2.44 m long formed by wooden planks placed in metal frame.
Intake:	Laundromat dryer drum welded to end of 175 mm diameter steel pipe sitting in head pond protected by trash rack.
Penstock:	Five ply rubber pipe 309 m long joined by specially fabricated clamps.
Powerhouse:	Wood frame building 2.44 m x 2.44 m placed on a concrete pad.
Turbine:	5 kW "Dependable" Pelton turbine.
Generator:	5 kW, 56 VDC marine alternator from Davidson Marine Electric.
Invertor:	48 VDC to 110/220 VAC solid state invertor from Best Energy Corporation.
Transmission Line:	Buried No. 2 Teck Cable 91.4 m long.

2. Background

Mr. Neal Livingston's micro hydro system is located in Black River, Inverness County, on his own property. A study carried out by Maritime Resource Management Service (MRMS) determined that Mr. Livingston's proposed site was suitable for a micro hydro installation.A flexible system would be required, capable of handling flows ranging from 0.15 m^3/min to 1.53 m^3/min.

3. Design

The first step taken by Mr. Livingston was to gather some hydrological data for the drainage basin by constructing a weir in the stream bed at the proposed powerhouse site. Information gathered during a three month period indicated that the minimum flow should be approximately 0.37 m^3/min. A later study by MRMS estimated that, the flow would range from a minimum of 0.15 m^3/min. to a maximum of 1.53 m^3/min. with an average flow of 1.04 m^3/min.

The layout of the system was designed by Mr. Livingston to develop the maximum head over the shortest distance, while remaining close to his home to minimize the transmission distance. Individual components of the system were constructed in or near the stream bed.

A concrete dam 0.6 m high by 5.5 m long was constructed in the stream bed to create a small head pond. A 2.44 m long section in the center of the dam is formed by wooden planks slotted into a steel frame. This section acts as a spillway for flows in excess of the capacity of the system and the planks can be removed from time to time to drop the water level for cleaning the head pond. Water flowing into the head pond during periods of normal flow passes through a trash rack.

The intake is a stainless steel laundromat dryer drum with a 380 mm flange welded to the open end which is attached to a 175 mm diameter steel pipe. Perforations in the dryer drum allow water to flow into the steel pipe but filter out the smaller debris which passes through the trash rack. Flow

from the intake into the penstock is controlled by a valve in the steel pipe. Air entrained in the flow at the intake is removed by a standpipe attached to the steel pipe just downstream of the dam.

The penstock is 309 m long and follows the route of the brook from the dam to the powerhouse. It is constructed of 175 mm diameter rubber hose previously used by the navy as fuel loading hose. It is joined by specially fabricated clamps.

The powerhouse consists of a wood frame building 2.44 m x 2.44 m constructed on a concrete pad (Plate 1). It shelters the turbine, generator, invertor, storage batteries and electrical control equipment.

Dependable Turbines in Port Moody, B.C. built the 254 mm diameter Pelton wheel runner and carried out much of the work associated with selecting the equipment components necessary to assemble the micro hydro system. The turbine was designed to work efficiently for flows between 0.19 and 2.24 m^3/min. Three water jets are directed at the turbine from three nozzles all with shut off valves. Two of the nozzles are 25 mm in diameter and the third port has interchangeable nozzles 25 mm, 19 mm or 13 mm in diameter. This allows the turbine to operate efficiently over a wide range of flows.

Hydrological investigations revealed that stream flows were not adequate for year round alternating current generation. For this reason a 5 kW brushless 56 VDC marine alternator from Davidson Marine Electric in Vancouver, B.C. was selected as the generating unit. Also installed as a part of the generating system was a solid state invertor capable of changing 48 VDC to 110/220 VAC and six 8 V marine batteries. This system is flexible because it transmits power at the lower transmission losses of AC and includes the capability of battery storage for subsequent DC power.

Best Energy Corporation of Necedah, Wisconsin manufactured the solid state invertor. It has a normal load capacity of 5 kW and is capable of handling surge loads as high as 20 kW which allows the use of the induction motor. Conversion efficiency of DC power to AC power is 90%. Power transmission from the powerhouse to the dwelling is via 92 m of buried No. 2 Teck Cable.

Another feature of the system is a pressure switch installed at the turbine which stops the invertor if the penstock pressure falls below 152 KPA which is half of the normal operating pressure. This protects the batteries which could be damaged if they were completely discharged during the winter months.

4. Contracting

In general the work was not contracted out. Only construction of the concrete dam was performed by a contractor. The owner with the help of locally hired labour and equipment performed all other tasks.

5. Construction

The equipment such as the turbine and generator was ordered in June of 1980 and arrived on site at the beginning of September. Construction got under way in mid July. The micro hydro system began generating power on October 11, 1980.

Environmental approval of Water Rights Application and for the construction of the hydro system did not present any difficulties.

6. Operating Experience

Since the micro-hydro system was put into operation in October 1980, daily generation has averaged 24 - 55 kWH. During September when water levels are low, output drops to 250 - 300 W per day for up to three weeks. Close control of power consumption during this period is necessary to ensure that power is available continuously.

Few operating problems have been encountered since this system has been put into operation. Occasionally the invertor will not turn on the induction motor and on one occasion the invertor actually burned out.

Maintenance of the unit is relatively simple. The unit is inspected on a regular basis and any problems noted are immediately rectified. The generator bearings require greasing and all electrical connections are inspected regularly. Water is added to the storage batteries once a year.

7. Construction Cost Summary

Mr. Livingston estimates the total installed cost of his system at $22,800. The following is an approximate breakdown of the costs as supplied by Mr. Livingston.

Dam	$ 2,000
Penstock	$ 3,000
Inventor	$ 3,200
Batteries	$ 1,000
Turbine	$ 6,500
Generator	$ 1,500
Misc. Materials & Labour	$ 5,600
TOTAL	$22,800

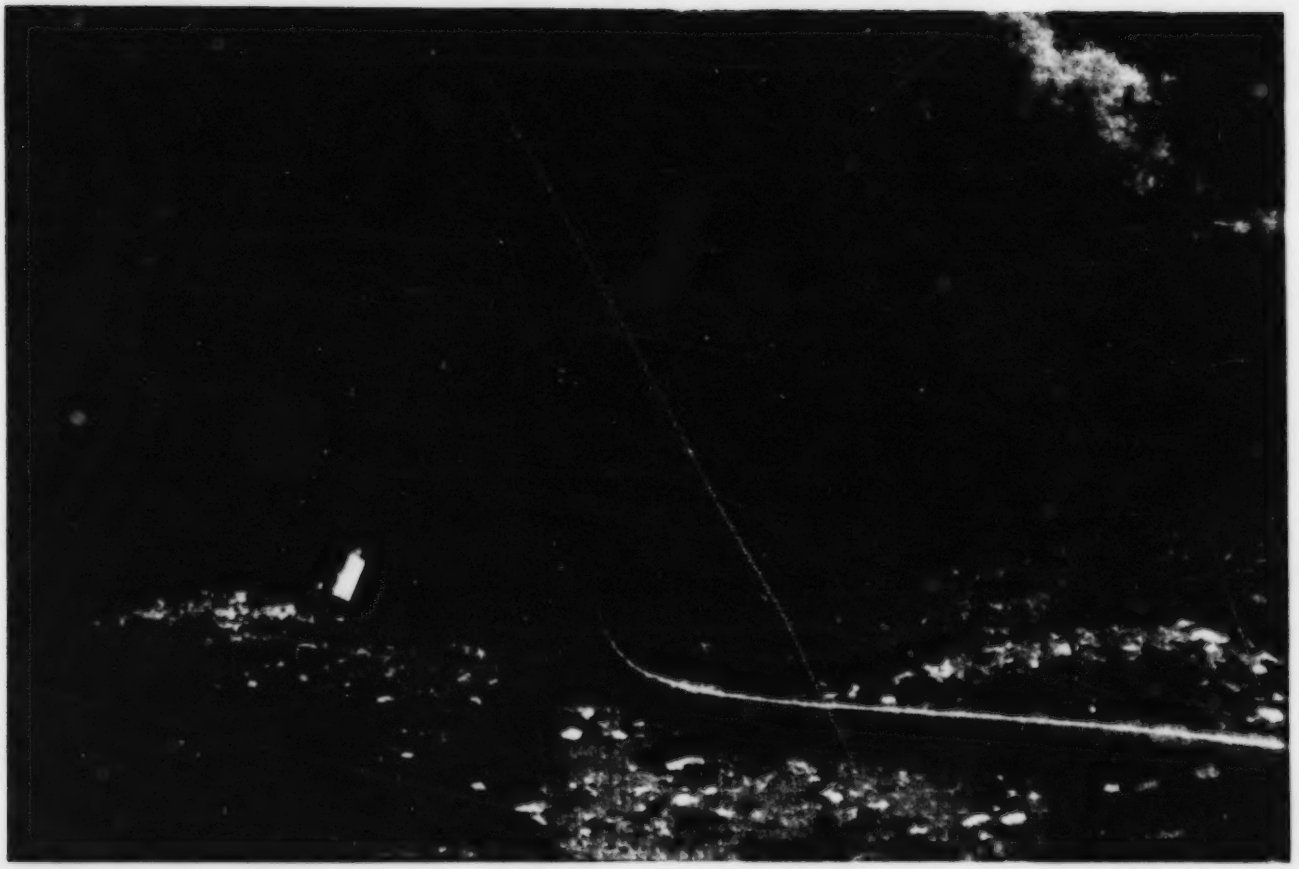


Plate 1: Wood frame powerhouse on concrete pad. The rubber hose in the foreground is the penstock.

MELFORD BROOK DEVELOPMENT

1. **Project Summary**

Name:	Melford Brook Development
Owner:	Mr. Neal Livingston Mabou Inverness County, Nova Scotia BOE 1XO Tel: (902) 258-3354
Capacity:	225 kW
Net Head:	66.8 m
Dams:	Constructed of impervious and common fill.
Intake:	Reinforced concrete structure consists of trashrack, one 1.52 m diameter intake conduit, an intake tower, and one 0.76 m diameter downstream conduits.
Penstock:	0.76 m diameter reinforced concrete pipe approximately 1950 m long.
Powerhouse:	5.5 m x 5.5 m prefabricated metal building on concrete foundation.
Turbine:	225 kW, 535 mm diameter "Turgo" turbine from Dependable Turbines.
Generator:	335 hp induction generator.
Transmission Line:	Constructed by N.S.P.C. for Black River Hydro.

2. Background

The Melford Brook Development is located in Guysborough County in Middle Melford near the Strait of Canso.

Mr. Neal Livingston became interested in developing a larger hydro scheme from his experience with his own 5 kW unit which supplies his domestic power. During research on this subject Mr. Livingston discovered the Melford Brook Water Supply Scheme which was constructed but never put into service. A prefeasibility study was performed which determined that hydro power could be produced using water from the Melford Brook Water Supply. An economic analysis performed by Mr. Livingston based on estimated construction and operational costs and on information supplied by N.S.P.C. found that the project was economically viable. Based on this information Mr. Livingston decided to proceed with the development.

3. Design

The hydrology of the drainage basin serving the Melford Brook Development was determined at the time the water supply scheme was designed. A firm flow of 0.41 m^3/s was available for hydro power generation.

The layout of the Melford Brook Development took advantage of the structures already in place for the water supply scheme. Hydro power generation equipment was simply constructed at the end of the existing water supply pipeline and a tail race excavated to Melford Brook.

Design of the Melford Brook Water Supply Scheme was performed by Monenco Limited. A water supply reservoir was created by constructing seven small earthfill dams which, in general, are founded on consolidated till. Only a portion of one dam which includes a reinforced concrete overflow spillway is founded on sound bedrock.

The reinforced concrete intake structure, also a part of the original water supply scheme, consists of a trashrack entrance, one 1.52 m diameter intake conduit, an intake tower, and three 0.76 m diameter downstream conduits.

Three 0.76 m diameter vertical intake gates, manually operated from the deck of the intake, are provided for unwatering the three downstream chambers of the intake structure. Flow into the conduits is regulated by three sluicegates which are identical to the intake gates. Two of the three 0.76 m diameter reinforced concrete conduits are terminated with blind flanges approximately 30 m from the downstream toe of the dam. The third conduit, which forms the penstock, continues downhill from this point approximately 1905 m to terminate at a valve chamber. A surge allowance of 25% was provided for the conduit.

Design of the Melford Brook Hydro Development began at the downstream side of the valve. A connection pipe was run from the valve to the new powerhouse. Much of the design work associated with the turbine, generator, control equipment and powerhouse was performed by Dependable Turbine in Port Moody, B.C., the turbine supplier.

The turbine was sized to operate at peak capacity year round. A 225 kW Turgo turbine with two nozzles was found to be suitable for this application (Plate 1). The turbine drives a 335 hp, 600 V induction generator. Operation of the unit is micro computer controlled and protected with a phone link to either the plant caretaker or Mr. Livingston.

A prefabricated metal building on a concrete foundation designed by Dependable Turbine forms the powerhouse (Plate 2). The layout of the equipment inside the powerhouse was also set out by the turbine supplier. Water discharged from the turbine flows back into Melford Brook through a 488 m long tailrace which is simply an excavated trench.

The generator output was cable connected at 600 V and stepped up to 25 kv for transmission. N.S.P.C. constructed a new transmission line to the site of the new powerhouse.

4. Contracting

Mr. Livingston functioned as his own contractor. The individual items of work such as powerhouse construction and tailrace excavation were subcontracted out. Dependable Turbine provided a foreman for two weeks to supervise installation of the major pieces of equipment.

5. Construction

Major equipment components for the Melford Brook Development were ordered in January 1984. Construction began on May 15, 1984, was completed on July 1, 1984, and the unit began generating power immediately.

As is evidenced by the short construction period, no major problems were encountered during construction.

Leases to use the water utility and adjacent land and water rights took two years to obtain.

6. Operating Experience

Operation of the Melford Brook Development is virtually maintenance free. A plant caretaker visits the installation usually once per day but, because of weather conditions, a full week may pass between visits. A micro computer controls the operation of the unit and in the event of unit malfunction notifies the caretaker or Mr. Livingston by phone.

Very few problems have occured since the unit was put into operation. The micro computer malfunctioned and was replaced. On another occasion a turbine seal failed and resulted in damage to the turbine bearings. It took approximately one week to replace the bearings and put the unit back in service.

Maintenance is scheduled every six months. At that time the Melford Brook Development is thoroughly inspected and the unit is completely greased and oiled. Other maintenance is carried out as required.

7. Construction Cost Summary

The construction cost summary for the Melford Brook Development does not include the construction costs for the original water supply development. The original water supply development, which cost approximately $4.6 million in 1976, included site clearing, access road construction, dam construction, spillway construction, intake construction, and pipeline construction.

Construction of the Melford Brook Development only involved a short extension of the existing conduit, erection of the powerhouse, purchase of equipment, and excavation of the tailrace. The total cost for performing this work was approximately $275,000.00.

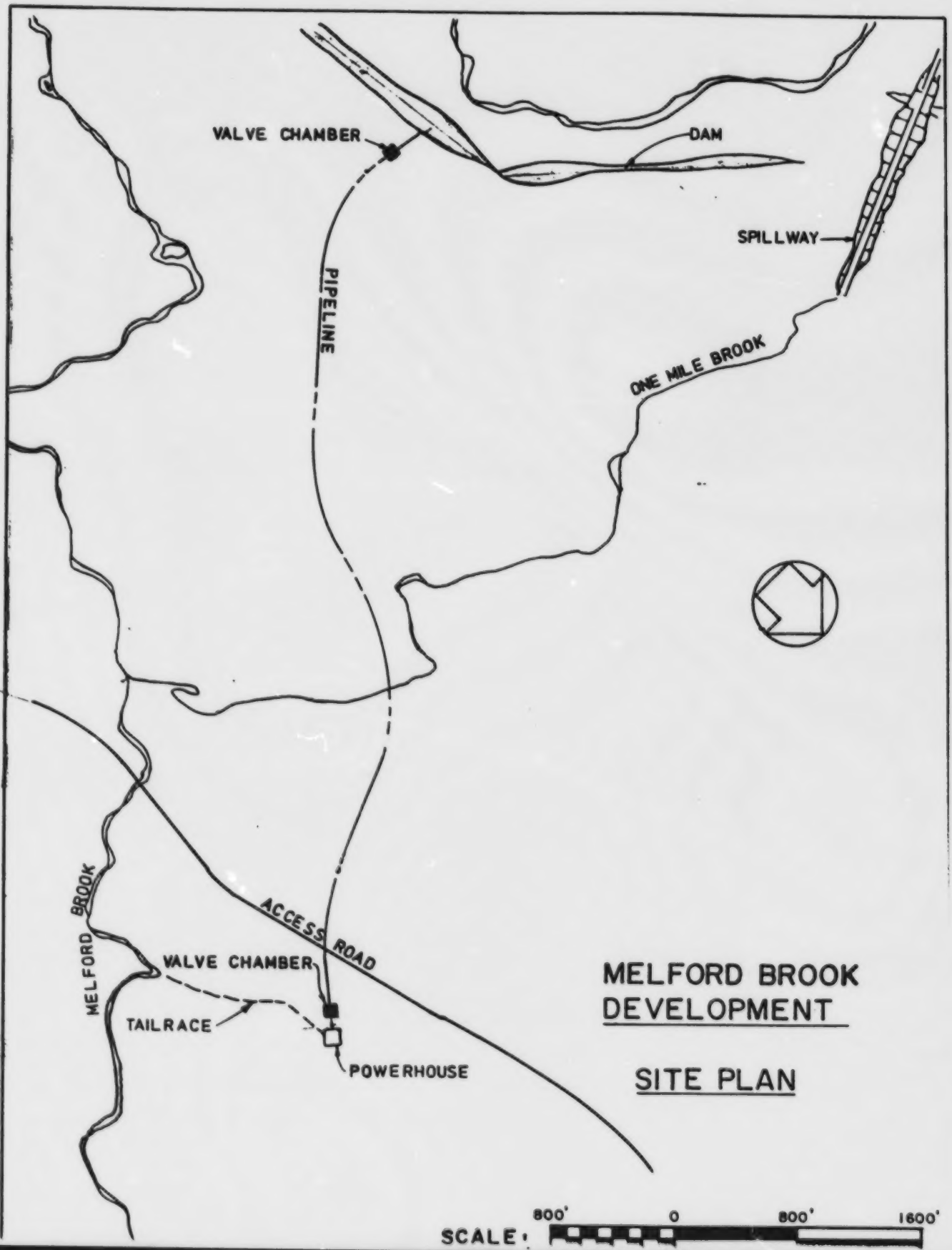

VALVE CHAMBER
DAM
SPILLWAY
PIPELINE
ONE MILE BROOK
MELFORD BROOK
ACCESS ROAD
VALVE CHAMBER
TAILRACE
POWERHOUSE
MELFORD BROOK
DEVELOPMENT
SITE PLAN
SCALE:
800'
0
800'
1600'

Plate 1: 225kW Turgo turbine connected by a horizontal shaft to the 335 hp induction generator at the left of the photograph.

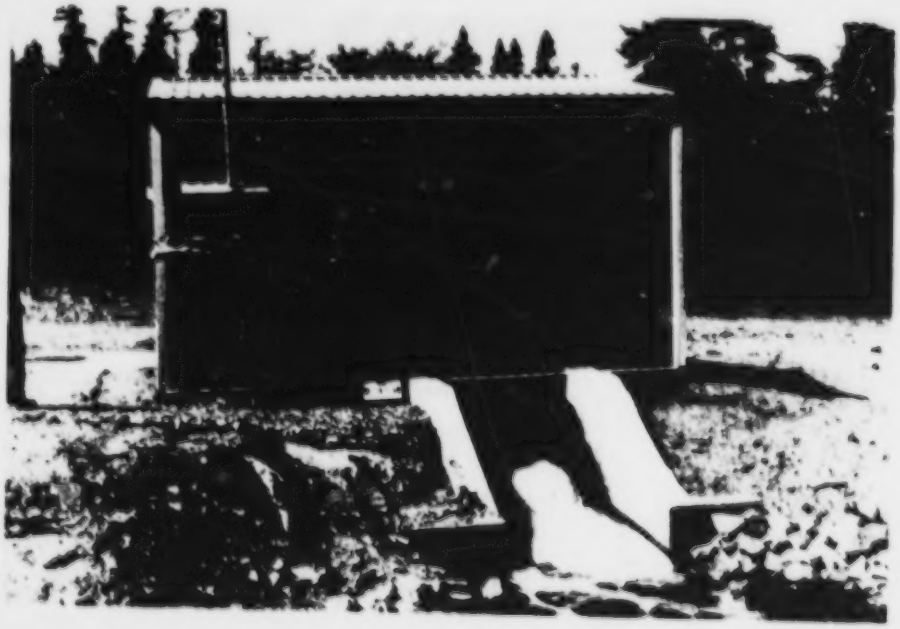


Plate 2: Prefabricated metal powerhouse showing the discharge from the turbine and the beginning of the tailrace canal.

HYDRO POWER FOR LIFE

1. **Project Summary**

Name: Hydro-Power For Life

Owner: Mr. R. Solomon
R. R. #1
Dingwall, N. S.
B0C 1G0
Phone: 1-902-383-2191

Capacity: 5 kW

Gross Head: 100 m

Dam: Approximately 20 m long by 1.5 m high constructed of stone, and mortar and creosote timber placed on solid rock in the stream bed.

Intake: Stainless steel, upright cylindrical filter placed in a small head pond and protected by a trash rack.

Penstock: The upper 305 m is 175 mm diameter rubber hose; the lower 183 m is 150 mm diameter Class 150 PVC pipe.

Powerhouse: Wood frame building 2.45 m by 2.45 m built on a concrete foundation.

Turbine: A jet engine gas turbine 343 mm in diameter modified to permit connection to the generator.

Generator: Refurbished International 15 kW, 3 phase, 208 V generator.

Transmission Line: Consists of used 4/0 conductor strung on 8.5 m wood poles over a total length of 275 m.

2. Background

In the past Mr. Solomon heated his home by burning wood. In 1980, he began looking into alternate methods to supply heat, including electricity from hydro power. Mr. Solomon constructed a weir in a small stream on his property to determine how much water would be available if he were to construct a micro hydro plant. He then heard about grants that were available from the federal/provincial Small-Scale Energy Demonstration Program for micro hydro developments and completed a successful application.

3. Design

At the outset of the design phase very little information was available about the hydrology of the drainage basin except the weir readings taken by Mr. Solomon over an eight month period. From the weir measurements Mr. Solomon estimated that the average flow available for his development would be 1.1 m^3/min. but the flow would vary widely throughout the year. To take advantage of the wide variation in flow it was decided to use a Pelton like turbine runner. The turbine is a modified gas turbine driven by water emitted from three nozzles (Plate 3). Various nozzle sizes are used for different flows. Water is removed from the turbine enclosure via a pipe and discharged back into the stream.

The actual layout and design of the project was performed by Mr. Solomon except for the modifications to the gas turbine and the design of the turbine water nozzles.

A small head pond was created in the stream by placing a stone and mortar dam faced with creosoted timber across the stream (Plate 1). The stream flows into the head pond through a trash rack which, during periods of high flow is self-cleaning. An upright, stainless steel, cylindrical filter attached to the upstream end of the penstock forms the intake.

The penstock is constructed of two different materials. The upper 305 m is 175 mm diameter rubber hose previously used by the navy as fuel loading hose, joined by specially fabricated clamps. Polyvinyl chloride Class 150 pipe, 150 mm in diameter, forms the lower 183 m of the penstock where the internal water pressure is too great for the rubber hose. The entire penstock is buried in a shallow trench from the intake to the powerhouse.

A simple wood-frame building erected on a concrete foundation forms the powerhouse (Plate 2). It houses the turbine, generator and electrical control equipment.

The generator is a refurbished international 15 kW three phase unit. It is connected to the turbine by a specially designed shaft. Power from the generator is transmitted to the house by a 275 m long transmission line. Wood poles 8.5 m high are strung with used 4/0 conductor. Transmission voltage is 208 V three phase.

4. Contracting

Only a small portion of the work was contracted out. Mr. Solomon purchased all of the materials and performed most of the work by hand. The items of work contracted out were:

1. Excavations of the penstock trench.
2. Excavation for the powerhouse.
3. Excavation for the transmission line and poles.
4. Machine shop work to modify the turbine and manufacture the nozzles.

5. Construction

Construction of this micro hydro installation began in the fall of 1981 with the clearing of the right-of-way. The project was completed late in 1982. During the winter of 1981/82, material for construction of the dam was moved to the site and construction of the dam commenced in the spring of 1982.

The dam was constructed completely by hand beginning with excavation of the foundation in stream bed down to bedrock. Stone and mortar, faced with creosoted treated timber, was then placed on the cleaned rock to form the dam.

Installation of the intake, construction of the penstock, erection of the powerhouse, and erection of the transmission line was also performed by Mr. Solomon with the help of hired labour and equipment. A backhoe was used to excavate the penstock trench, excavate the powerhouse foundation and erect the transmission line poles. Everything else was done by hand including placing the powerhouse foundation, installing the turbine and generator, and stringing the conductor.

Few problems were encountered during construction. Obtaining environmental approval for construction of the micro hydro system did not present any difficulty.

6. Operating Experience

Mr. Solomon put the micro hydro system into operation late in 1983. Very few problems have been encountered during the operation of the plant. The penstock was broken on one occasion when a valve in the powerhouse was closed too quickly but, in general, breakdowns have been rare.

Maintenance of the unit is also very straight forward. Operation of the intake is virtually maintenance free as is the case for the rest of the system. The only item noted as requiring periodic attention is the seal on the shaft connecting the turbine to the generator. It must be repacked every three months.

7. Cost Summary

Mr. Solomon estimates that the total cost of the project is $16,000.00. This does not include the cost of Mr. Solomon's labour nor does it reflect the replacement cost of the used equipment and materials installed during construction.

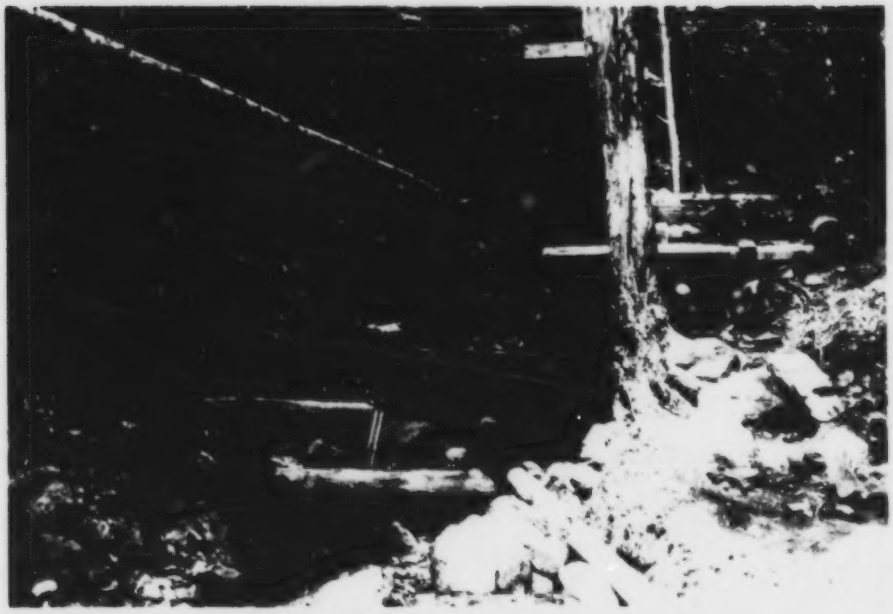


Plate 1: Dam constructed of stone and mortar faced with creosote treated timber.

Plate 2: Wood frame powerhouse erected on a concrete foundation.

Plate 3: Modified gas turbine runner with nozzels shown inside turbine enclosure. The pipe shown in the lower left of the photograph discharges water from the turbine enclosure.

FALL RIVER DEVELOPMENT

1. Project Summary

Name:	Fall River Development
Owner:	Nova Scotia Power Corporation
Capacity:	500 kW
Net Head:	25.4 m (normal operation)
Spillway:	Concrete overflow spillway approximately 3.7 m high controls Miller Lake water level. A gated structure controls the discharge from Soldier Lake.
Intake:	Concrete, gated with trash racks and fish screens.
Penstock:	Fiberglass reinforced plastic pipe 1219 mm diameter and 174 m long connected to a concrete culvert running underground from the intake through the road embankment.
Powerhouse:	Pre-engineered metal building placed on a concrete substructure.
Turbine:	Barber horizontal axis Francis turbine rated at 500 kW mounted on an extension of the generator shaft.
Generator:	500kW random wound induction generator three phase 600 V, 600 RPM.
Transmission:	Extends 100 m from the powerhouse to a small switchyard which feeds an existing transmission line.

2. Background

The Fall River Development is located approximately 16 km north of Halifax in Fall River, Halifax County. An analysis carried out by Nova Scotia Power Corporation (NSPC) concluded that replacing the abandoned hydro

development at Fall River would be economically viable. On the basis of this study the existing powerhouse and penstock were demolished and the new development constructed.

3. Design

The hydrology of the drainage basin flowing into Fall River was well established prior to commencing design of the new hydro development because of the data available from the operation of the existing plant. It is estimated that the Fall River Plant will generate 2200 MWH of electricity annually.

Layout of the Fall River Project was not changed from the layout of the original installation (Sketch 1). In fact the Miller Lake spillway was a part of the original development. The new penstock follows the route of the old penstock and the new powerhouse is constructed on the old powerhouse site.

Design of the Fall River Development was performed by NSPC. The existing Miller Lake spillway structure was modified to include the new intake structure complete with operable control gates and trash racks (Plate 1). Part of the existing intake was modified to accommodate the new intake.

Fiberglass reinforced plastic pipe with double "o" ring bell and spigot joints is used for the 174.1 m long penstock. Pipe wall thickness varies from 10.4 mm at the upper end, where it joins the existing concrete culvert,to 15.0 mm where it enters the powerhouse. Steel thimbles are used to connect the plastic pipe to the concrete culvert and to where the penstock enters a concrete anchor block at the powerhouse. The upper end of the penstock is backfilled to the pipe spring line with Class "A" gravel. Only the last 35 m of the penstock is completely buried to a depth of approximately 0.6 m. An emergency shut down of the unit subjects the penstock to a maximum pressure of 530 kPa, twice the maximum static head.

A pre-engineered metal building (Plate 2) sized to enclose the turbine, generator, hydraulic equipment, electrical control panel and sufficient space to perform major repairs to the equipment forms the powerhouse superstructure. The powerhouse substructure is cast in place reinforced concrete. Entrance into the building is via a 3.6 m x 3.6 m overhead door or a single mandoor. A 4.5 tonne overhead travelling crane with a manual hoist is provided to facilitate maintenance of the unit. Powerhouse ventilation is achieved by a direct drive roof ventilator and a 9 m square motorized louvre in the west wall. Both ventilators are thermostatically controlled. Six 2 kW thermostatically controlled radiant heaters provide powerhouse heating.

The turbine/generator set (Plate 3), which arrived at site as a single unit with the runner mounted on an extension of the generator shaft, consists of a horizontal Francis turbine and a random wound induction generator. Flow to the turbine from the penstock is controled by a 914 mm butterfly valve positioned at the entrance to the scroll case. The butterfly valve and the turbine wicket gates are powered by 4.14 MPa hydraulic pump-set. Discharge from the turbine is directed into the tailrace by a metal draft tube elbow. The unit, which operates at a nominal speed of 600 RPM, is rated at 500 kW. Speed of the unit during start up is governed by the control panel in combination with a magnetic speed sensor. When the unit is on line the speed is governed by the NSPC grid.

Power generated by the Fall River Station is fed at 25 kV via a short transmission line across the tailrace to a small switchyard (Plate 4). From the switch yard the power is fed into the provincial grid.

4. Contracting

The first contract let for the Fall River development was for the supply and installation of the generating and control equipment. Tenders for this particular package were by invitation only although a large number of firms were invited to bid. Public tenders were called for all the civil and electrical works.

NSPC provided full time engineering supervision to assist with layout, interpretation of drawings and to ensure that the work met the specifications. A representative from Barber, the turbine-generator supplier, assisted with commissioning the plant.

5. Construction

The major equipment components for the Fall River Development were ordered in January of 1985. Construction, including demolition of the existing powerhouse and penstock, began in May of 1985 and was completed in October. Commissioning was completed in November of 1985 when the unit went on line.

No major problems were encountered during construction. The trouble free construction of the Fall River Development is attributed to awarding the construction contract to a competent general contractor and the fact that the development was being built on the site of a demolished unit.

Environmental approval of the Water Rights Application for this project was not a problem since the water rights had already been approved for the existing plant. The only restriction placed on water withdrawal from Miller Lake was that the level of the lake be maintained at or above elevation 48.3 m from June 15 to September 15 each year.

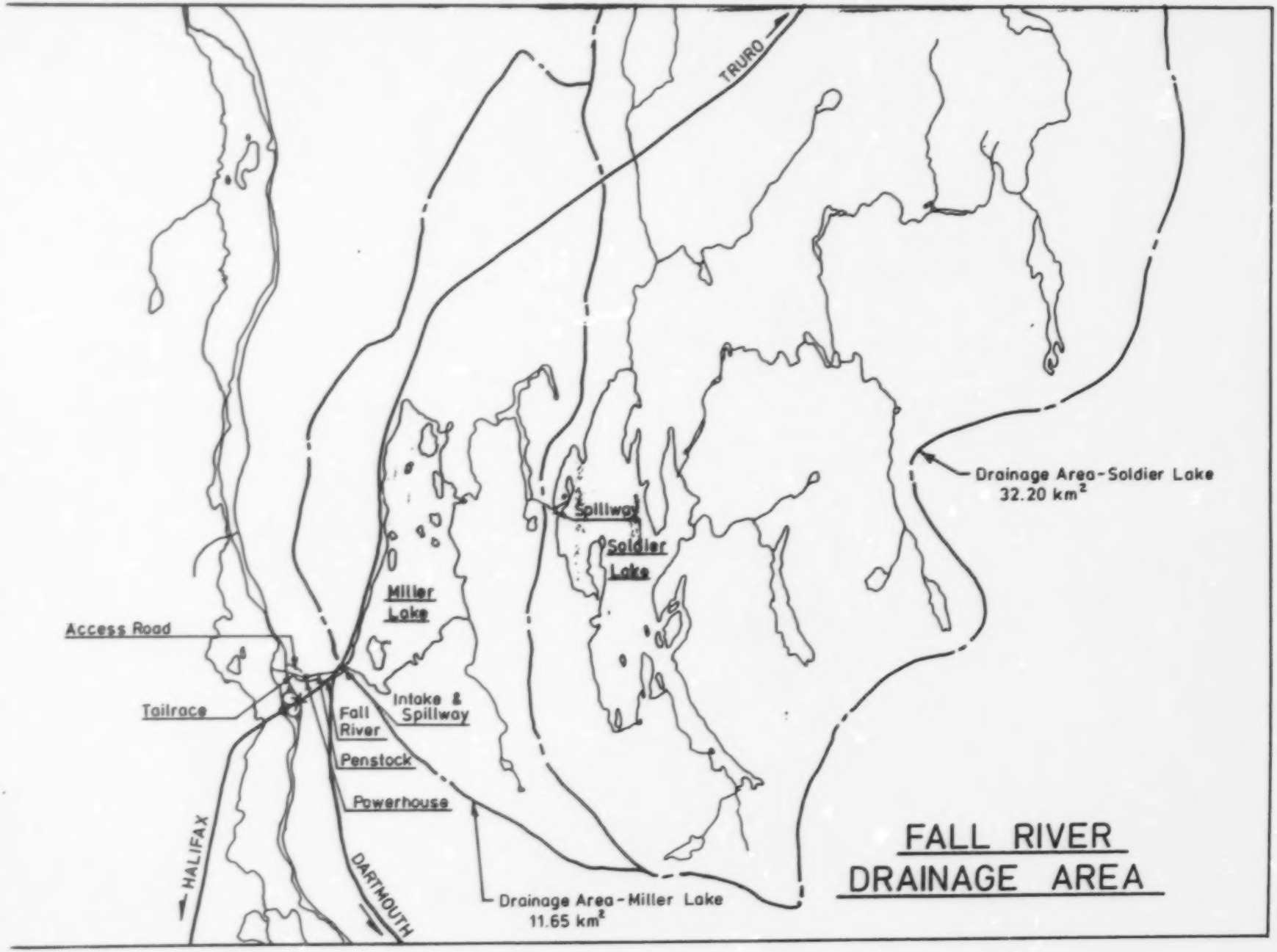
6. Operating Experience

Start up of the generating unit must be initiated locally (manually). Unit shutdown is accomplished either by a local timer or by a level sensor warning that the low lake level (elev. 47.74 m) has been reached. In general, the unit is operated at full capacity for a set time each day. The time span is calculated to fully utilize the water available in the reservoir without drawing down Miller Lake below the spillway crest (elev. 48.3 m) during the summer months or below elevation 47.74 m for the remainder of the year.

Fall River Development has operated virtually trouble free since it was commissioned in October of 1985. Maintenance of the unit is limited to greasing the unit periodically, a thorough inspection of the entire system every year and correcting minor problems that are noted during daily inspections.

7. **Construction Cost Summary**

Design, Tendering & Contract Management		$ 224,785
Construction		
Powerhouse	$ 128,468	
Turbine, Generator and Auxillary Electrical Equipment	$ 498,584	
Transmission Line & Substation	$ 48,968	
Penstock	$ 115,190	
Miller Lake Intake Improvements	$ 63,913	
Soldier Lake Dam Improvements	$ 72,768	$ 927,891
Interest & Overheads		$ 132,500
		$1,285,176


TRURO
Drainage Area-Soldier Lake
32.20 km²
Spillway
Soldier Lake
Miller Lake
Access Road
Tailrace
Intake & Spillway
Fall River
Penstock
Powerhouse
HALIFAX
DARTMOUTH
Drainage Area-Miller Lake
11.65 km²
FALL RIVER
DRAINAGE AREA

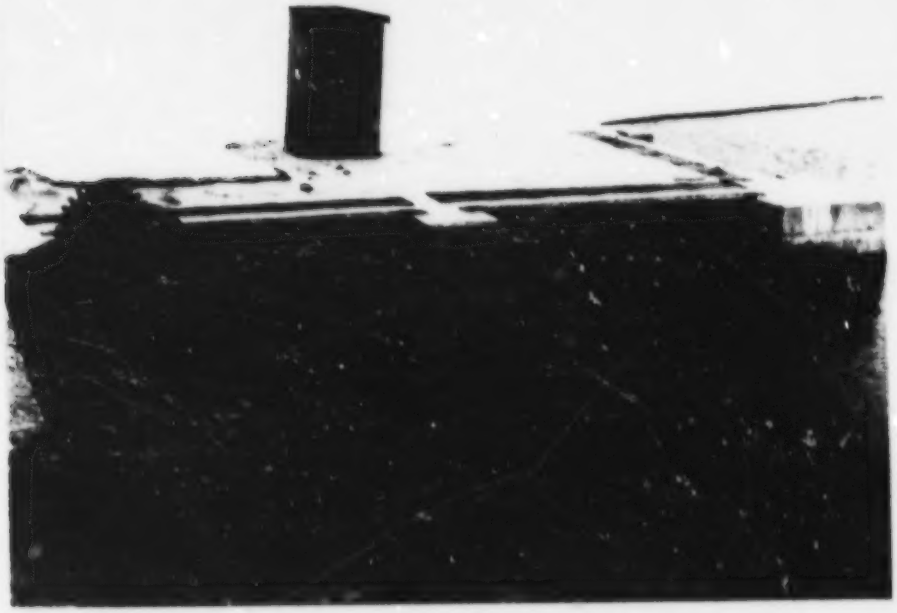


Plate 1: New intake structure showing trash racks. A portion of the existing concrete dam is shown in the lower left of the photo.

Plate 2: Pre-engineered metal powerhouse.

Plate 3: Horizontal axis Francis turbine in background and 500kW generator in foreground. A portion of the prefabricated metal draft tube is shown at the extreme right of the photograph.

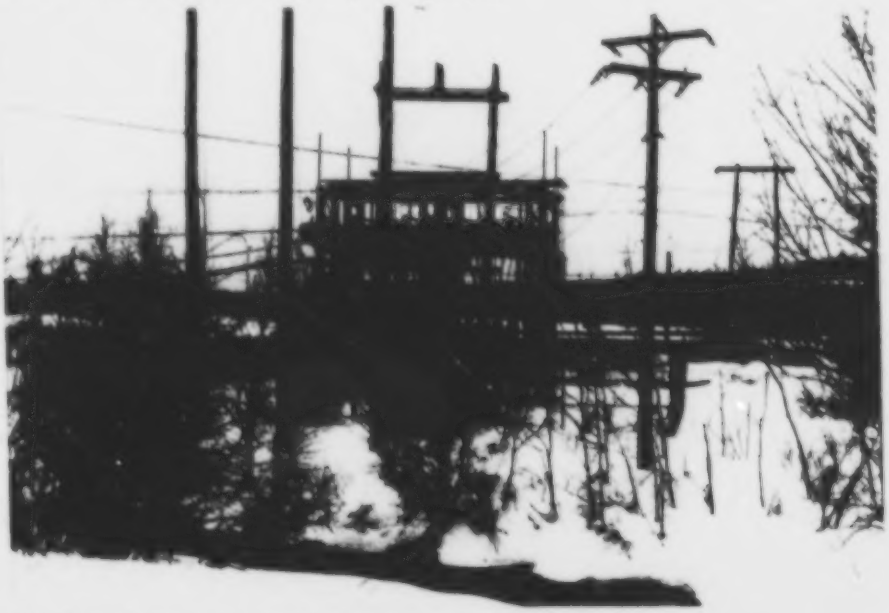


Plate 4: Switchyard for the Fall River Development.

FACTORYDALE DEVELOPMENT

1. **Project Summary**

Name: Factorydale Development

Owner: Berwick Electric Commission
P.O. Box 130
Berwick, Nova Scotia
BOP 1EO

Capacity: 520 kW

Gross Head: 23.8 m

Dam: Concrete gravity structure 121 m long by 4.3 m high.

Intake: Concrete chamber in dam with manually operated wood gate controlling flow into chamber, trash racks inside chamber.

Penstock: Wood stave pipe 1219 mm in diameter and 313 m long with wood stave surge tank.

Powerhouse: Cast in place reinforced concrete foundation, superstructure of structural steel frame with concrete block walls, metal roof deck with built up roofing.

Turbine: Vertical shaft Francis turbine develops 520 kW at 514 RPM.

Generator: 520 kW Canadian General Electric 514 RPM, 2400 V, 3 phase.

Transmission Line: 9700 m long, 12 kV, 3 phase, No 4 solid copper wire conductor with No 4 ACSR neutral on wood poles.

2. Background

The Berwick Electric Commission hydro plant is located at Factorydale, Kings County, Nova Scotia. A 125 kW installation was first put into service on the site in the early 1920's. It was later replaced with a 250 kW unit which was in operation until the mid 1960's. During the period 1959 to 1965 the Berwick Power Commission, because of the state of disrepair of the 250 kW plant, was considering either selling or overhauling the unit. Numerous proposals for repairing or selling the plant were received during that period and it was on the basis of a proposal that it was decided to replace the existing 250 kW unit with the present 520 kW plant.

3. Design

The hydrology of the drainage basin serving the Factorydale plant was well established from the operating records of previous plants.

Design of the Factorydale generating station proceeded based on the Berwick Electric Commission's purchase of a used 520 kW generator from NSPC (Plate 1) which requires a flow of $2.37 m^3/sec.$ at a gross head of 23.8m to operate at peak capacity. The individual components were designed to achieve the peak capacity of the generator.

An extensive repair program for the existing concrete gravity dam (Plate 2) was required due to the deterioration of the concrete which had been in place since the early 1920's. Five areas on the dam required separate modifications, including the addition of a large volume of concrete in the area of the intake. A new, manually operated, wood intake gate and new trash racks were also included in the dam repair design.

A wood stave pipe (Plate 3) 1219 mm in diameter and 313 m long forms the new penstock. Surge protection is provided by a wood stave surge tank 864 mm in diameter.

A new powerhouse was designed to house the new turbine, refurbished generator, and mechanical and electrical control equipment. The powerhouse measures 4.52 m X 3.66 m on draft tube floor and 6.91 m X 5.69 m on generator floor. Chas. Barber & Sons supplied the vertical axis Francis turbine rated at 520 kW at 514 RPM complete with cylindrical steel pressure case, discharge connections, gauge board and gauges, Woodward oil pressure governor, 1219 mm diameter butterfly valve and a steel thimble. The draft tube discharges directly into the South Annapolis River.

The power is transmitted at 12 kV 3 phase, along a wood pole transmission line 9700 m long. The conductor is No. 4 solid copper and the neutral line is No. 4 ACSR.

4. CONTRACTING

The 520 kW Canadian General Electric generator was purchased used from NSPC. Canadian Westinghouse Company Limited submitted a proposal to completely overhaul and install the generator. This proposal was accepted by the Berwick Electric Commission.

Chas. Barber & Sons, Meaford, Ontario submitted another proposal for supply and installation supervision of a 520 kW Francis Turbine. The Berwick Electric Commission also accepted this proposal.

Public tenders were called for construction of the civil works. Work in the main contract included:

1. Demolition of existing penstock and powerhouse.
2. Repairs to existing concrete dam including supply and installation of a new wood intake gate and new trash racks.
3. Placement of intake thimble.
4. Installation including excavation and backfilling of the steel pipe under the Factorydale Road.

5. Excavation and backfill for wood stave penstock.
6. Construction of new powerhouse.
7. Installation and concreting for surge thimble.

Other work for which public tenders were called included:

1. Supply and setting of wood stave penstock.
2. Supply and installation of surge tank.
3. Supply of steel intake thimble, steel surge thimble and steel turbine thimble.

5. CONSTRUCTION

The Factorydale generating plant was constructed in 1967. Information concerning the construction schedule was not available but it was noted that the work was finished on time.

Information about problems encountered during construction was also not available. However, the plant superintendent noted the powerhouse excavation was not as deep as required and that the tailrace excavation was incomplete. No reason was given for the incomplete excavations but poor rock conditions were observed in the area of the powerhouse during our site visit.

6. OPERATING EXPERIENCE

The Factorydale generating plant was commissioned during the period late 1967 early 1968. Operation of the system is automatic and output is regulated by the flow of the South Annapolis River and not by the demand of the distribution system. This is due to the fact that power produced by the plant is less than the base demand of the customers of the Berwick Electric Commission.

Some minor operational problems were noted by the plant superintendant and include the following:

1. Severe plugging of the trash racks sometimes cause the scroll case pressure to drop.
2. The turbine vanes have plugged causing the unit to vibrate. The unit must then be shut down and cleaned.
3. The draft tube floor failed and had to be replaced.
4. Grounding of the transmission line is faulty and sometimes energizes the telephone line.

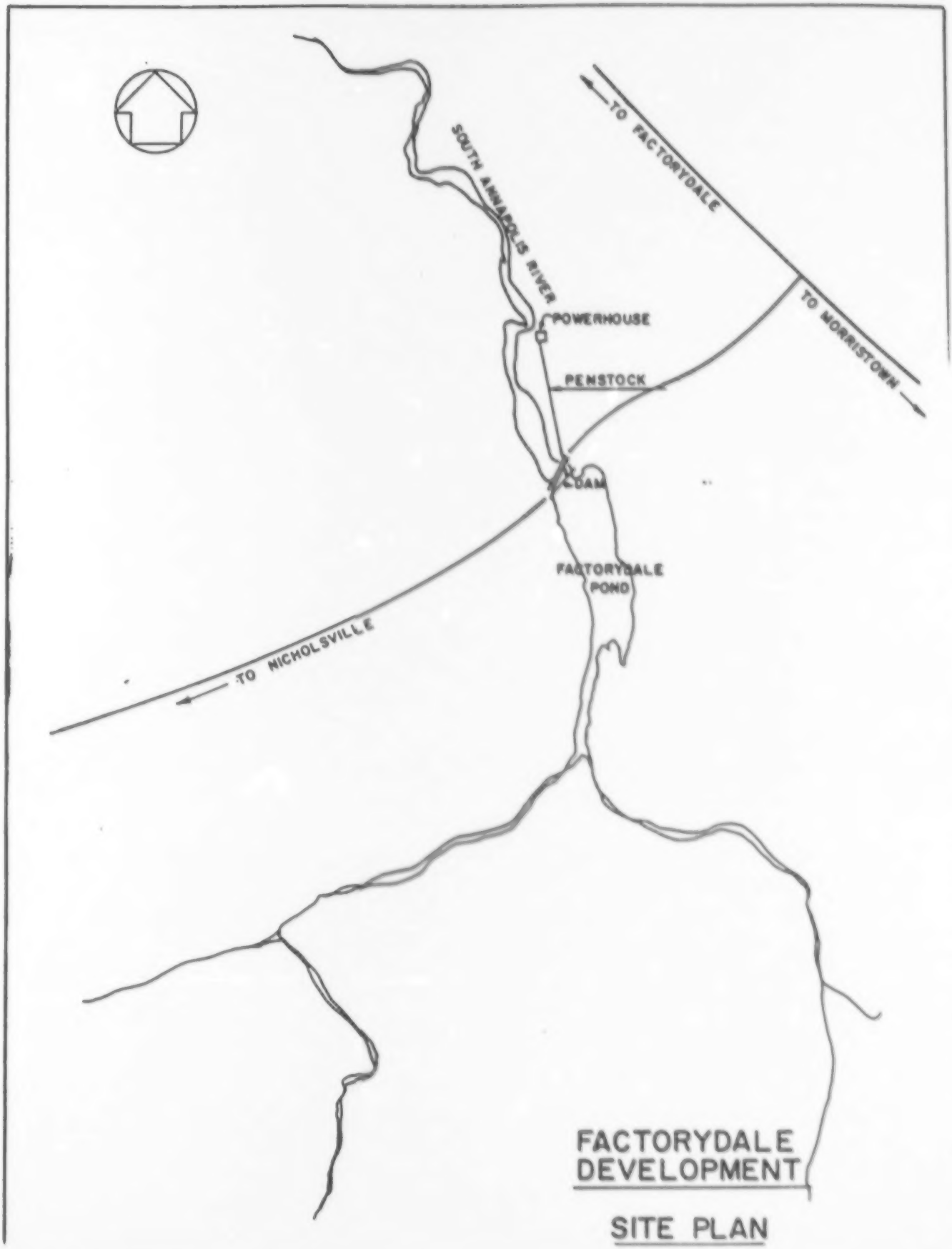
7. CONSTRUCTION COST SUMMARY

The construction cost information obtained is incomplete but the costs that are available are shown below. The figures quoted are in 1967 dollars.

Main Civil Contract	$ 66,000.00
Supply & Erect Penstock & Surge Tank	$ 35,000.00[1]
Supply & Install Turbine	$ 47,040.00[2]
Overhaul & Install Generator	$ 4,487.00[2]

1 Estimate based on price supplied for 1371 mm wood stave penstock.

2 Does not include erection supervision or labour.



FACTORYDALE DEVELOPMENT

SITE PLAN

Plate 1: 520kW generator that was purchased used from NSPC.

Plate 2: Concrete gravity dam showing the overflow spillway and on the left, the intake chamber with the manually operated wood gate in the raised position.

Plate 3: Wood stave penstock and surge tank. A portion of the powerhouse is shown in the middle of the photograph.

APPENDIX II

SITE DATA COMPUTER PRINTOUTS

WATER SHED : ST MARYS AT CROWS NEST

SITE NAME : M1

SITE DATA

INSTALLED CAPACITY	:	15.2 MW
PENSTOCK LENGTH	:	0 M.
DESIGN FLOW	:	67.7 M^3/S
PENSTOCK DIAMETER	:	3.630651 M.
RATED HEAD	:	26 M.
HEIGHT OF DAM	:	27 M.
TRANSMISSION LINE LENGTH	:	12.5 KM.
LENGTH OF DAM	:	250 M.
ACCESS ROAD LENGTH	:	.1 KM.
FLOOD FLOW	:	825.4 M^3/S
DISTANCE TO TOWN	:	12 KM.
NO.OF UNITS	:	2
DISTANCE TO CONCRETE PLANT	:	12 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 3.468218E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (STEEL)	UNWATERING
2858395	3231353	1066303	0	412700

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
2416375	4832751	1442612	10763.54	902795.5

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
1107000	799408.1	1810820	1675734

NOTE : SUBSTATION COST INCLUDED IN EQUIPMENT SUPPLY COST

PROJECT COST: $ 2.256701E+07 COST PER KW: $ 1484.672

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 2595206

ANNUAL BENEFIT : $ 6657600

BENEFIT/COST RATIO: 2.565346

WATER SHED : GOLD RIVER

SITE NAME : 65A

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	6.1 MW
PENSTOCK LENGTH	:	1600 M.
DESIGN FLOW	:	15.7 M^3/S
PENSTOCK DIAMETER	:	2.416338 M.
RATED HEAD	:	45 M.
HEIGHT OF DAM	:	16.8 M.
TRANSMISSION LINE LENGTH	:	.6 KM.
LENGTH OF DAM	:	150 M.
ACCESS ROAD LENGTH	:	.1 KM.
FLOOD FLOW	:	293 M^3/S
DISTANCE TO TOWN	:	10 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	10 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1.43337E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
913184.6	1055286	267028.5	1823496	146500

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
914221.3	1828443	545803.8	10763.54	43532.92

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
688800	256193.8	1143382	608070.6

NOTE : SUBSTATION COST INCLUDED IN EQUIPMENT SUPPLY COST

PROJECT COST: $ 1.024471E+07 COST PER KW: $ 1679.46

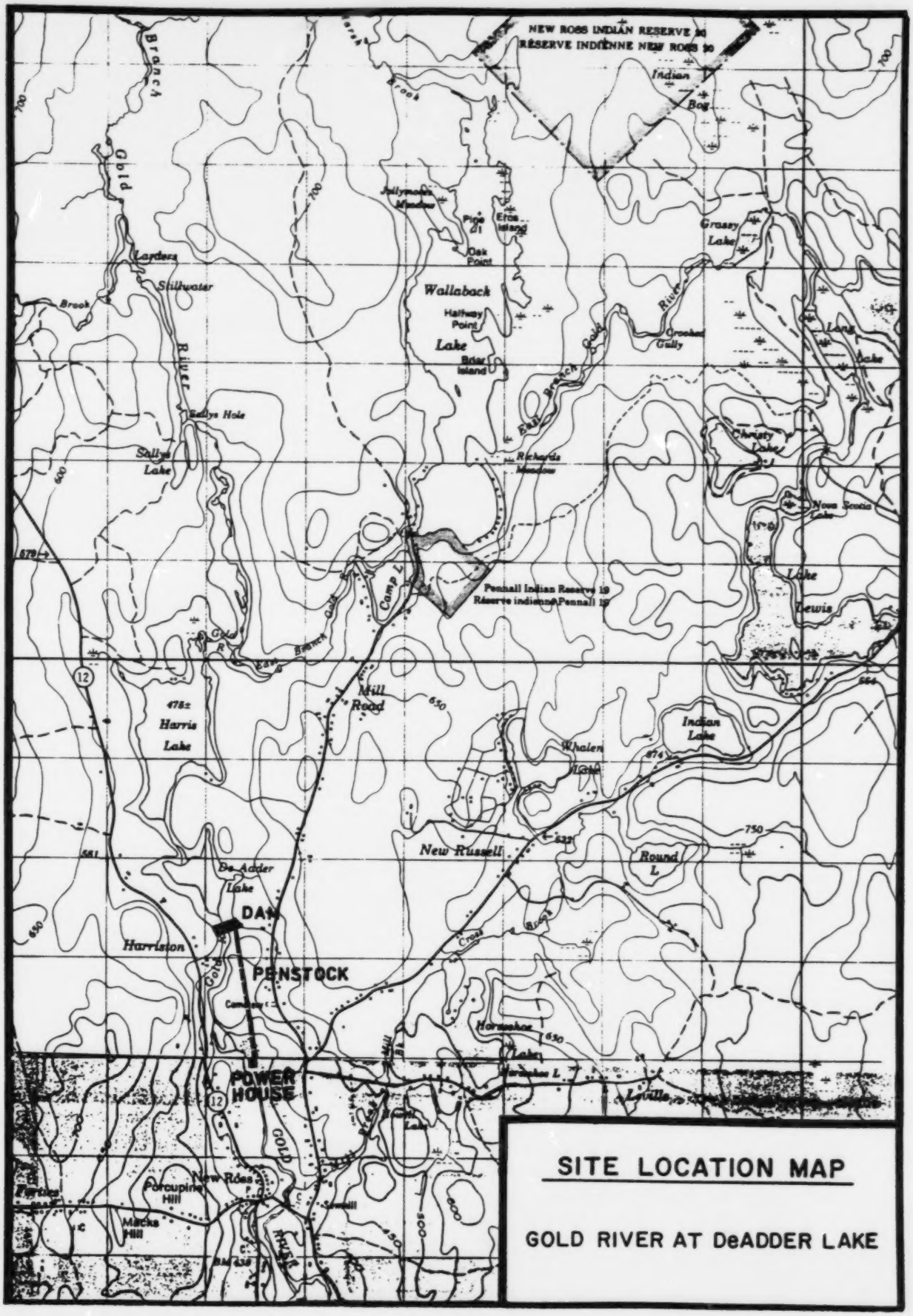
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1178141

ANNUAL BENEFIT : $ 2671800

BENEFIT/COST RATIO: 2.26781



SITE LOCATION MAP

GOLD RIVER AT DeADDER LAKE

WATER SHED : GOLD RIVER

SITE NAME : G3A

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	6.2 MW
PENSTOCK LENGTH	:	2000 M.
DESIGN FLOW	:	15.7 M^3/S
PENSTOCK DIAMETER	:	2.411122 M.
RATED HEAD	:	45.7 M.
HEIGHT OF DAM	:	15 M.
TRANSMISSION LINE LENGTH	:	.6 KM.
LENGTH OF DAM	:	550 M.
ACCESS ROAD LENGTH	:	.1 KM.
FLOOD FLOW	:	293 M^3/S
DISTANCE TO TOWN	:	10 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	10 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1.447105E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
2524311	983351.7	267028.5	2274438	146500

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
921741.8	1843484	550293.6	10763.54	43750.7

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
615000	348616.1	1385945	759955.3

NOTE : SUBSTATION COST INCLUDED IN EQUIPMENT SUPPLY COST

PROJECT COST: $ 1.267518E+07 COST PER KW: $ 2044.384

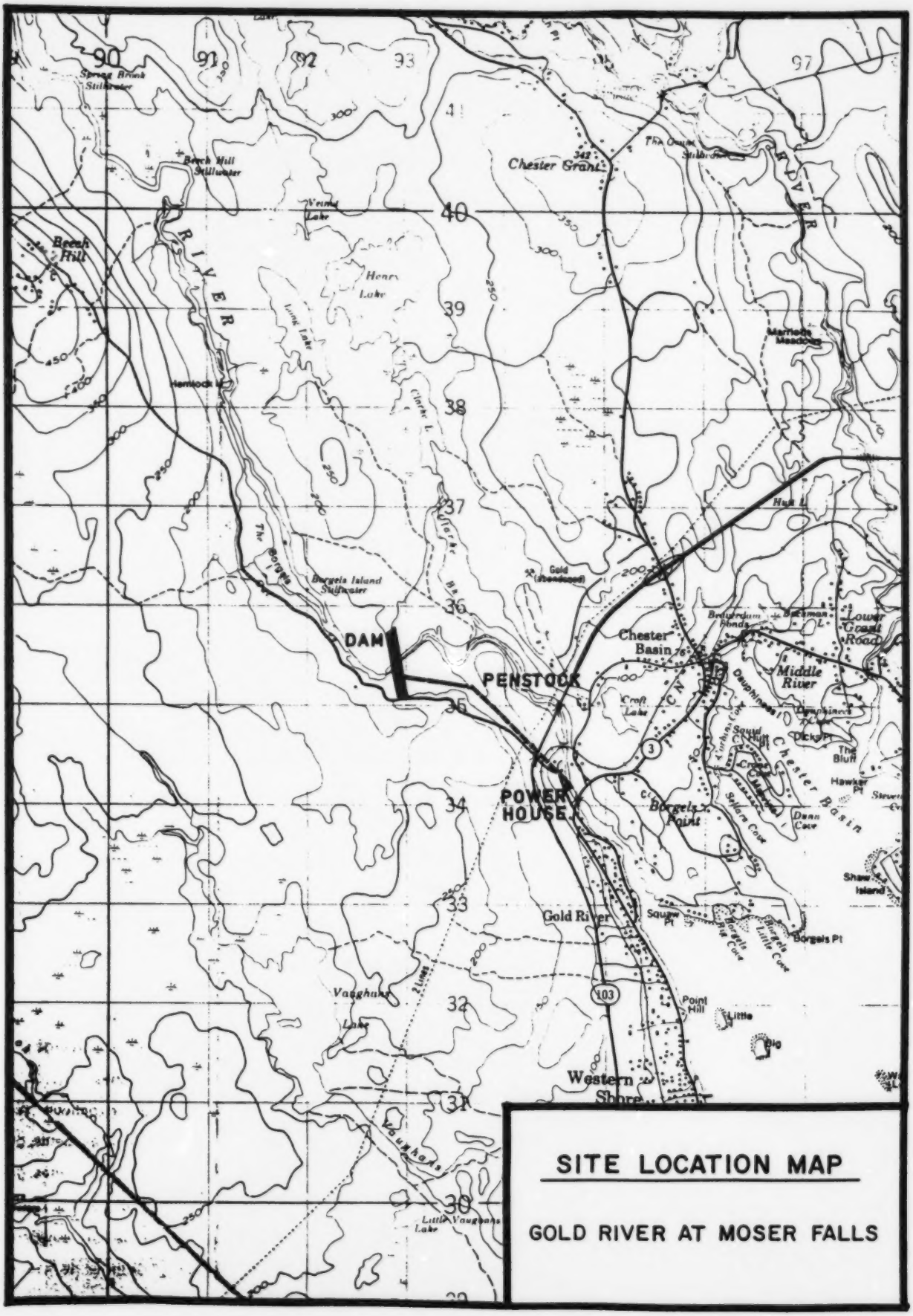
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1457646

ANNUAL BENEFIT : $ 2715600

BENEFIT/COST RATIO: 1.863004



SITE LOCATION MAP

GOLD RIVER AT MOSER FALLS

WATER SHED : WEST SHEET HARBOUR

SITE NAME : S3

SITE DATA

INSTALLED CAPACITY	:	3.56 MW
PENSTOCK LENGTH	:	250 M.
DESIGN FLOW	:	13.5 M^3/S
PENSTOCK DIAMETER	:	2.391179 M.
RATED HEAD	:	30.5 M.
HEIGHT OF DAM	:	15.2 M.
TRANSMISSION LINE LENGTH	:	.25 KM.
LENGTH OF DAM	:	300 M.
ACCESS ROAD LENGTH	:	.1 KM.
FLOOD FLOW	:	237.3 M^3/S
DISTANCE TO TOWN	:	1 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	1 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1.014213E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1488923	841069.2	233103.3	281947.4	118650

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
691254.3	1470754	441226.2	10763.54	199346.6

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
623200	24294.91	712161.3	294894

PROJECT COST: $ 7431588 COST PER KW: $ 2087.525

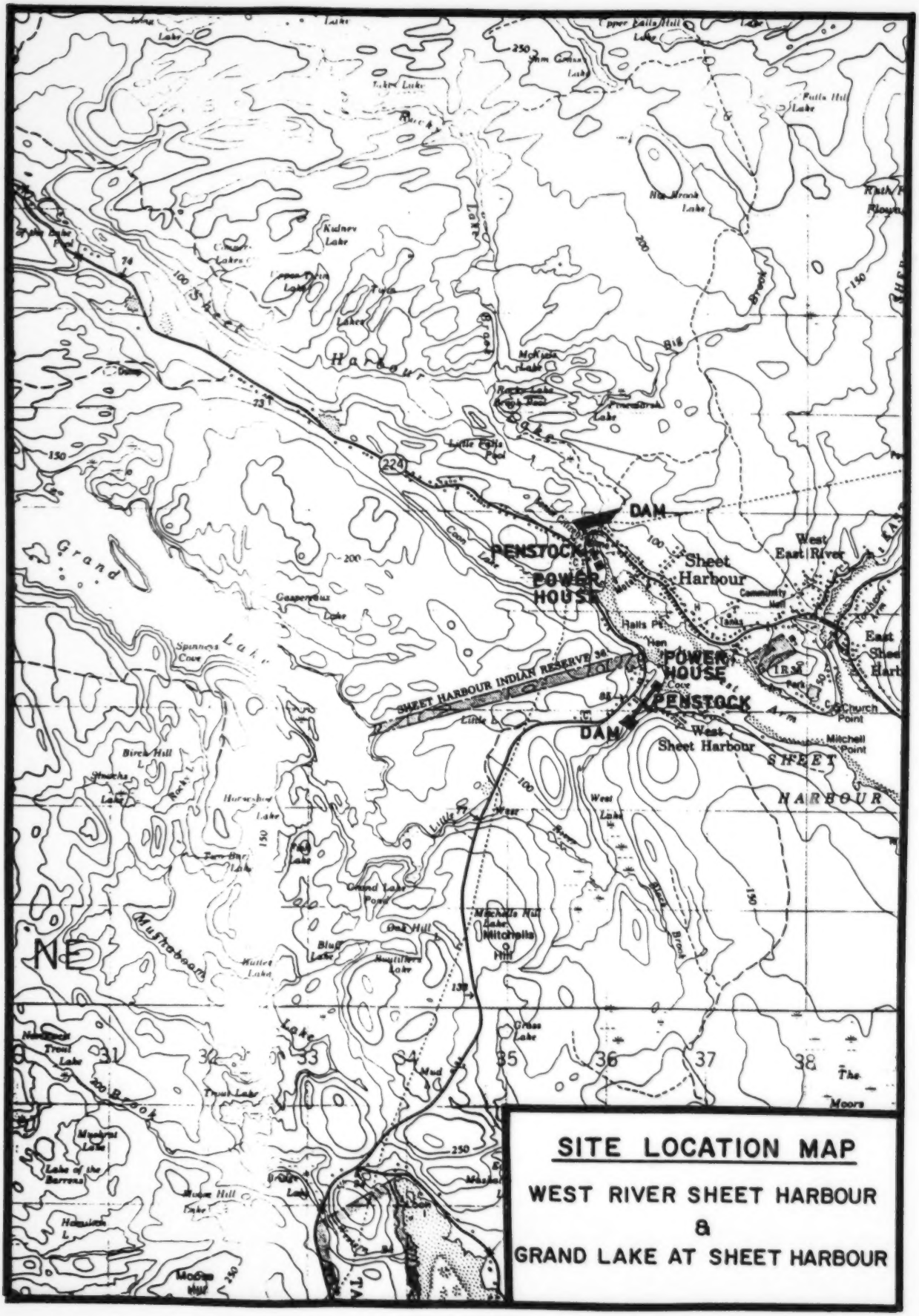
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 854632.6

ANNUAL BENEFIT : $ 1559280

BENEFIT/COST RATIO: 1.824503



SITE LOCATION MAP

WEST RIVER SHEET HARBOUR

&

GRAND LAKE AT SHEET HARBOUR

WATER SHED : TANGIER LAKE

SITE NAME : T1

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	: 4.5 MW
PENSTOCK LENGTH	: 1300 M.
DESIGN FLOW	: 11.3 M^3/S
PENSTOCK DIAMETER	: 2.091261 M.
RATED HEAD	: 46 M.
HEIGHT OF DAM	: 23 M.
TRANSMISSION LINE LENGTH	: 6.5 KM.
LENGTH OF DAM	: 150 M.
ACCESS ROAD LENGTH	: 4 KM.
FLOOD FLOW	: 207 M^3/S
DISTANCE TO TOWN	: 25 KM.
NO.OF UNITS	: 1
DISTANCE TO CONCRETE PLANT	: 25 KM.
USEFUL TURBINE FLOW RATIO	: .75
MAXIMUM TURBINE FLOW RATIO	: 1.5
LEAST COST	: $ 1.110897E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1423564	986381.6	198618	1281909	103500
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
705360.8	1500768	450230.3	247574.5	549145.1
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
943000	718419.6	1091042	502476	

PROJECT COST: $ 1.070199E+07 COST PER KW: $ 2378.22

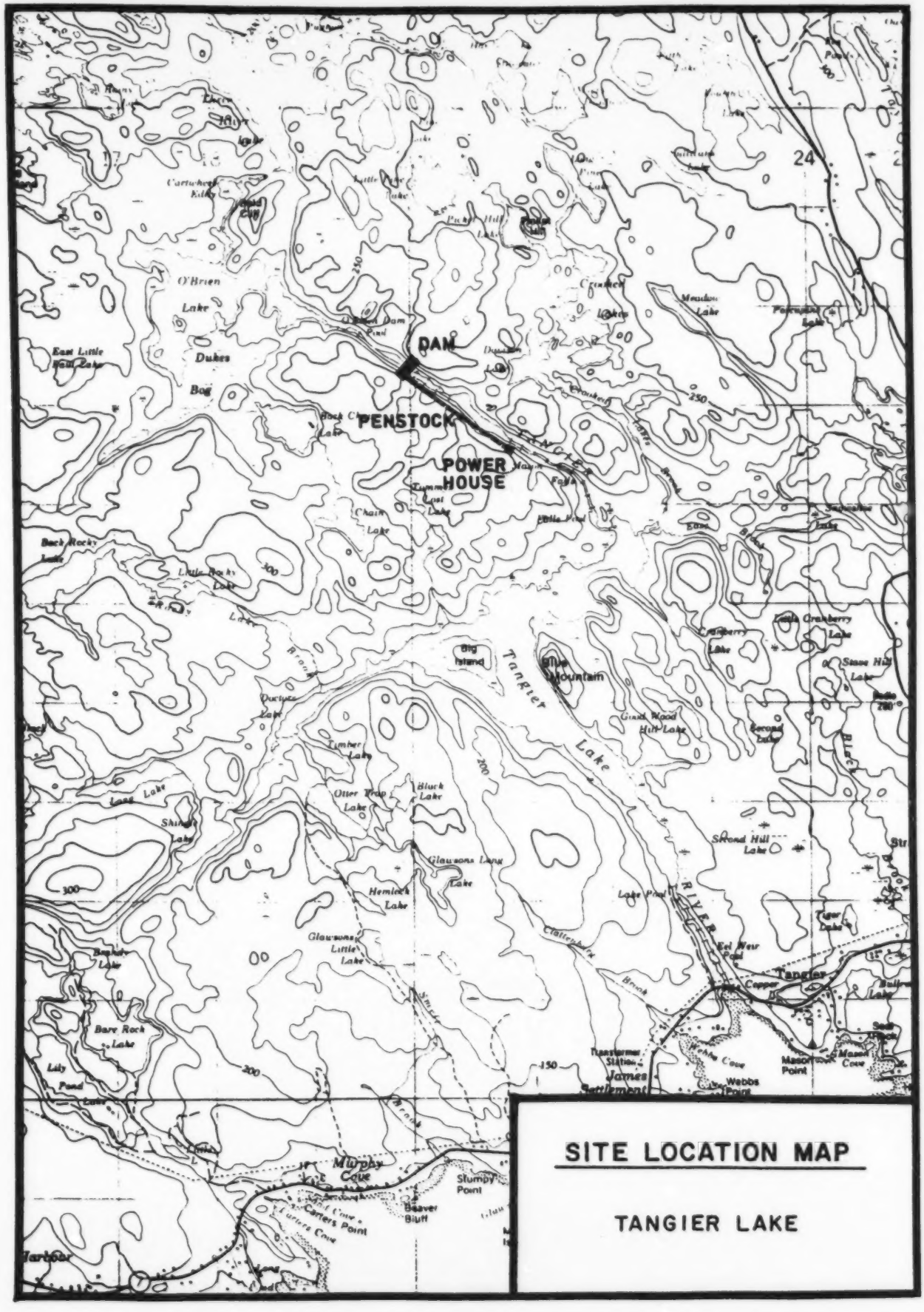
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1230729

ANNUAL BENEFIT : $ 1971000

BENEFIT/COST RATIO: 1.60149



SITE LOCATION MAP

TANGIER LAKE

WATER SHED : ECONOMY RIVER

SITE NAME : E1B

NOTE - TRANSMISSION LINE LENGTH EXCEEDS 10*MW

SITE DATA

INSTALLED CAPACITY	:	1.2 MW
PENSTOCK LENGTH	:	650 M.
DESIGN FLOW	:	2.97 M^3/S
PENSTOCK DIAMETER	:	1.180861 M.
RATED HEAD	:	45 M.
HEIGHT OF DAM	:	3 M.
TRANSMISSION LINE LENGTH	:	16 KM.
LENGTH OF DAM	:	20 M.
ACCESS ROAD LENGTH	:	5 KM.
FLOOD FLOW	:	92.9 M^3/S
DISTANCE TO TOWN	:	35 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	35 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 3778474

COST ESTIMATE SUMMARY ($)

DAM (TIMBER CRIB)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
33829.08	SEE DAM	59666.26	362080.4	46450

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
281793.1	599559.8	179868	299281.2	608731.2

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
123000	186470.7	361303.1	105708.3

PROJECT COST: $ 3247741 COST PER KW: $ 2706.451

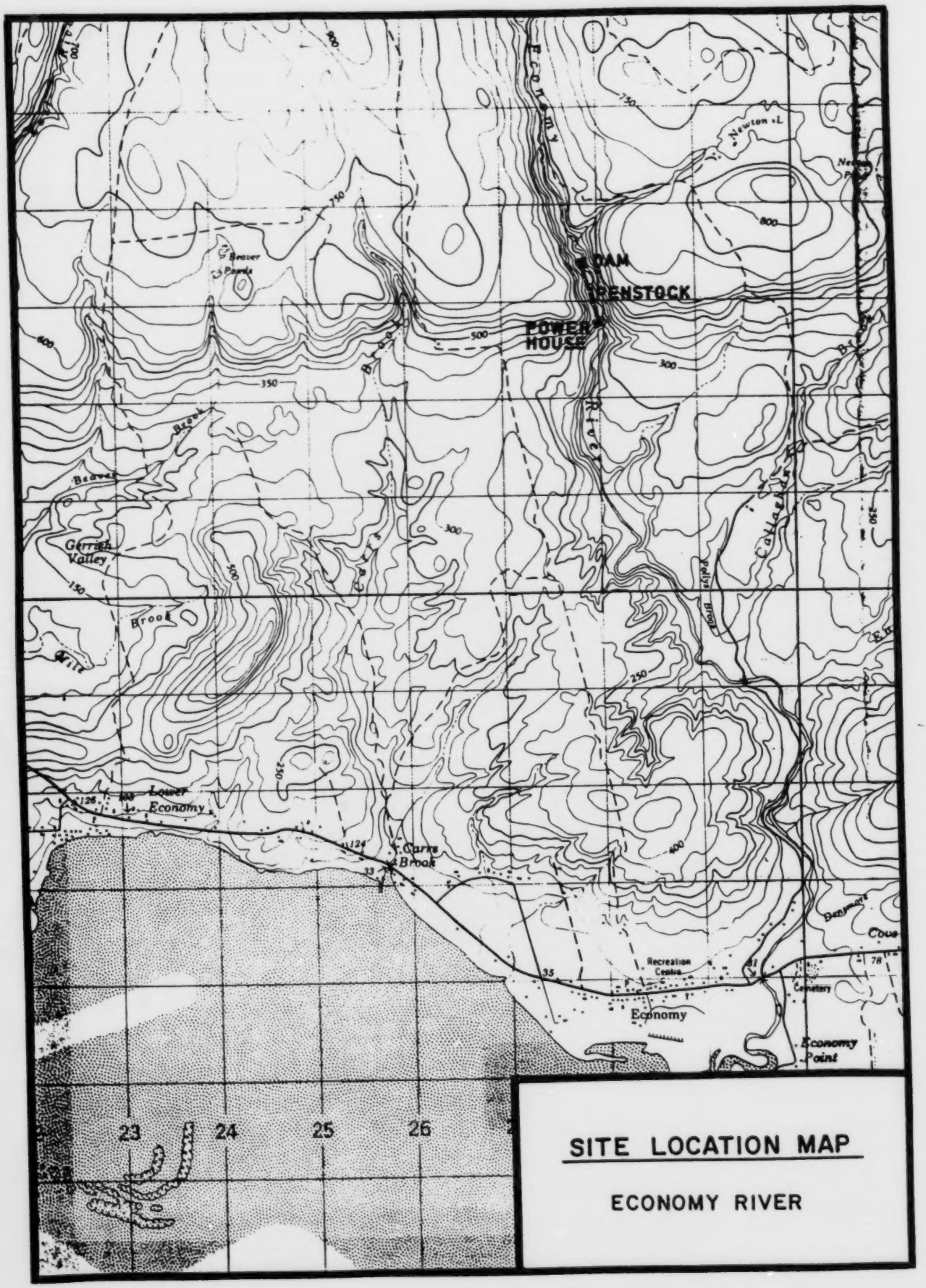
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 373490.3

ANNUAL BENEFIT : $ 525600

BENEFIT/COST RATIO: 1.407268


DAM
PENSTOCK
POWER HOUSE
Economy River
Newton L.
Beaver Ponds
Beaver Brook
Gerrish Valley Brook
Mill
Lower Economy
Clarke Brook
Recreation Centre
Cemetery
Economy
Economy Point
Dartmouth Cove
Callard
Yelpit Brook
23
24
25
26
SITE LOCATION MAP
ECONOMY RIVER

WATER SHED : GOLD RIVER

SITE NAME : 64

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	4.2 MW
PENSTOCK LENGTH	:	1500 M.
DESIGN FLOW	:	12.8 M^3/S
PENSTOCK DIAMETER	:	2.266215 M.
RATED HEAD	:	38 M.
HEIGHT OF DAM	:	15.2 M.
TRANSMISSION LINE LENGTH	:	15 KM.
LENGTH OF DAM	:	400 M.
ACCESS ROAD LENGTH	:	4 KM.
FLOOD FLOW	:	252 M^3/S
DISTANCE TO TOWN	:	25 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	25 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1.100312E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1928934	881438	222196.4	1603087	126000
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
718584.8	1528904	458671.2	247574.5	906840.4
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
623200	747350.5	1221130	559808.2	

PROJECT COST: $ 1.177372E+07 COST PER KW: $ 2803.266

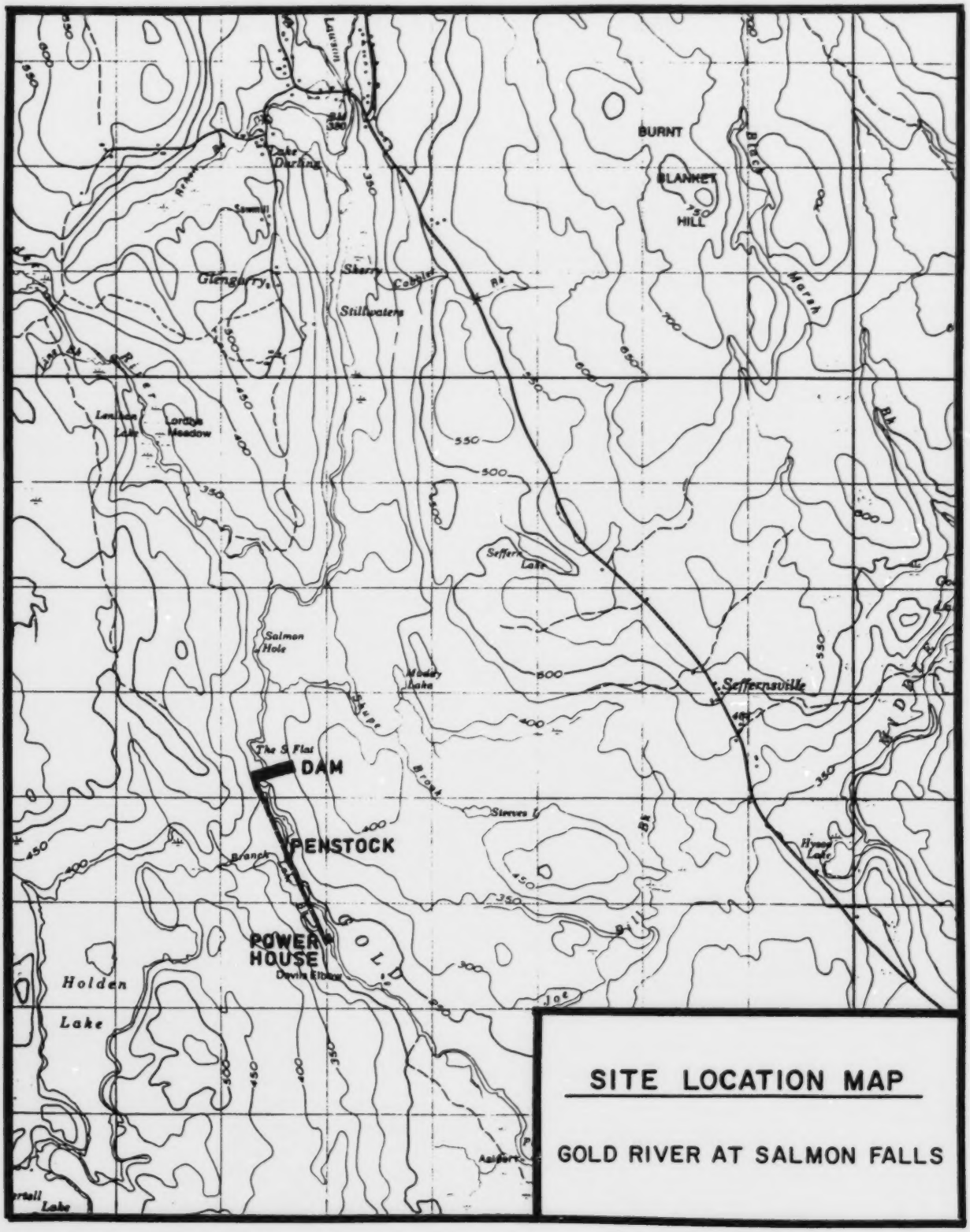
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1353979

ANNUAL BENEFIT : $ 1839600

BENEFIT/COST RATIO: 1.358664



SITE LOCATION MAP

GOLD RIVER AT SALMON FALLS

WATER SHED : GRAND LAKE AT SHEET HARBOUR

SITE NAME : 61

SITE DATA

INSTALLED CAPACITY	: .597 MW
PENSTOCK LENGTH	: 260 M.
DESIGN FLOW	: 2.25 M^3/S
PENSTOCK DIAMETER	: 1.106642 M.
RATED HEAD	: 30.5 M.
HEIGHT OF DAM	: 4.5 M.
TRANSMISSION LINE LENGTH	: 1 KM.
LENGTH OF DAM	: 100 M.
ACCESS ROAD LENGTH	: .1 KM.
FLOOD FLOW	: 60 M^3/S
DISTANCE TO TOWN	: 2 KM.
NO.OF UNITS	: 1
DISTANCE TO CONCRETE PLANT	: 2 KM.
USEFUL TURBINE FLOW RATIO	: .75
MAXIMUM TURBINE FLOW RATIO	: 1.5
LEAST COST	: $ 1924967

COST ESTIMATE SUMMARY ($)

DAM (CONCRETE)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
277792.8	SEE DAM	46474.24	135754.6	30000
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
198063.7	421412.2	126423.7	10763.54	100505.5
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
184500	9167.128	203634.6	46968.68	

PROJECT COST: $ 1791461 COST PER KW: $ 3000.771

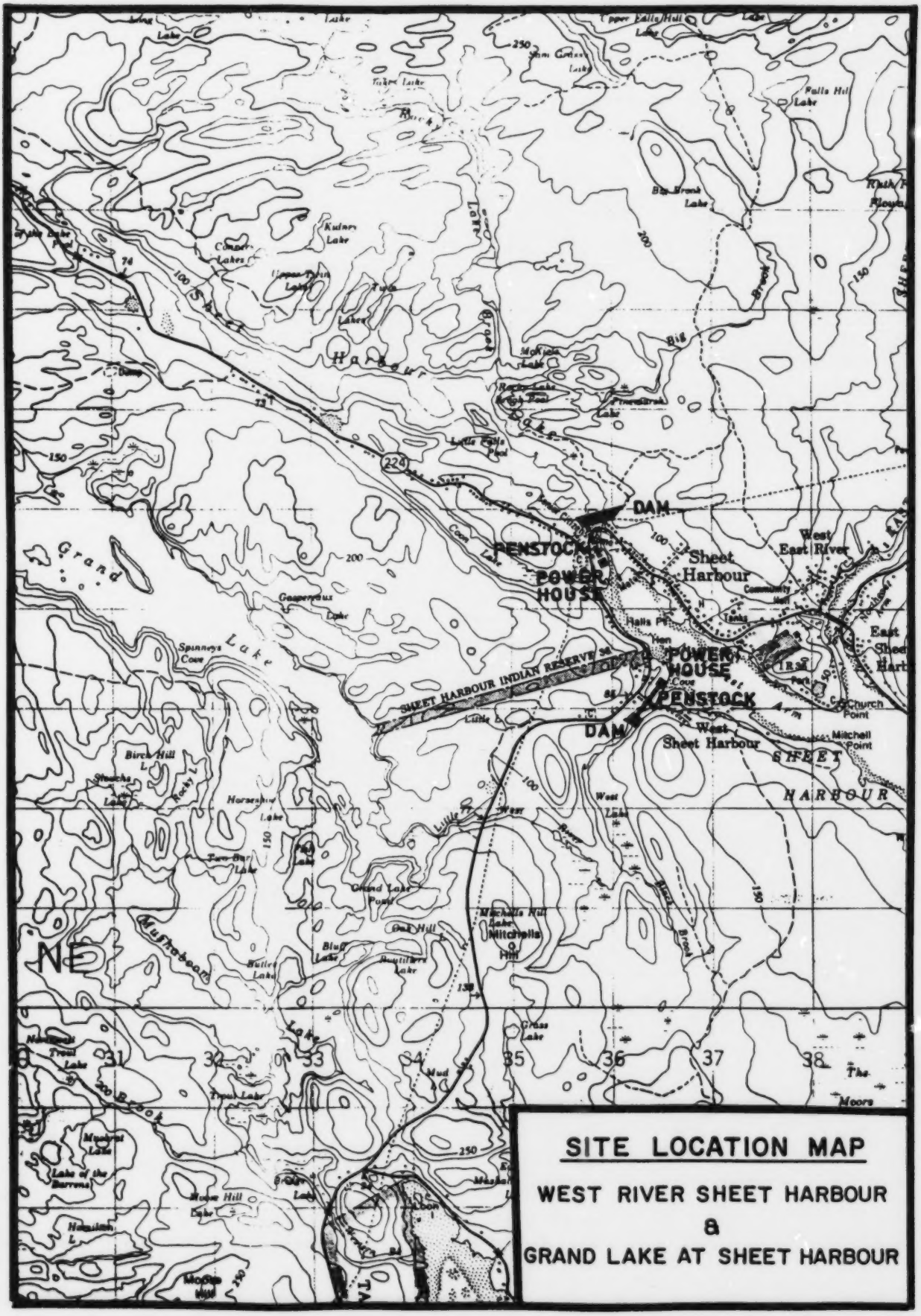
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 206018

ANNUAL BENEFIT : $ 261486

BENEFIT/COST RATIO: 1.269239



SITE LOCATION MAP

WEST RIVER SHEET HARBOUR

&

GRAND LAKE AT SHEET HARBOUR

SHYDRO-PC VERSION 2.0 MARCH 1986
MONENCO MARITIMES LTD

WATER SHED : CLYDE RIVER

SITE NAME : L1

SITE DATA

INSTALLED CAPACITY	:	3.17 MW
PENSTOCK LENGTH	:	50 M.
DESIGN FLOW	:	33.8 M^3/S
PENSTOCK DIAMETER	:	4.108574 M.
RATED HEAD	:	10.7 M.
HEIGHT OF DAM	:	10 M.
TRANSMISSION LINE LENGTH	:	1.5 KM.
LENGTH OF DAM	:	700 M.
ACCESS ROAD LENGTH	:	.5 KM.
FLOOD FLOW	:	515 M^3/S
DISTANCE TO TOWN	:	5 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1.193214E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (STEEL)	UNWATERING
1886740	1203134	532442.8	302321.1	257500
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
919570.4	1956533	586959.9	42274.6	252045.1
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
410000	210841.9	871606.8	358610.4	

PROJECT COST: $ 9790579 COST PER KW: $ 3088.511

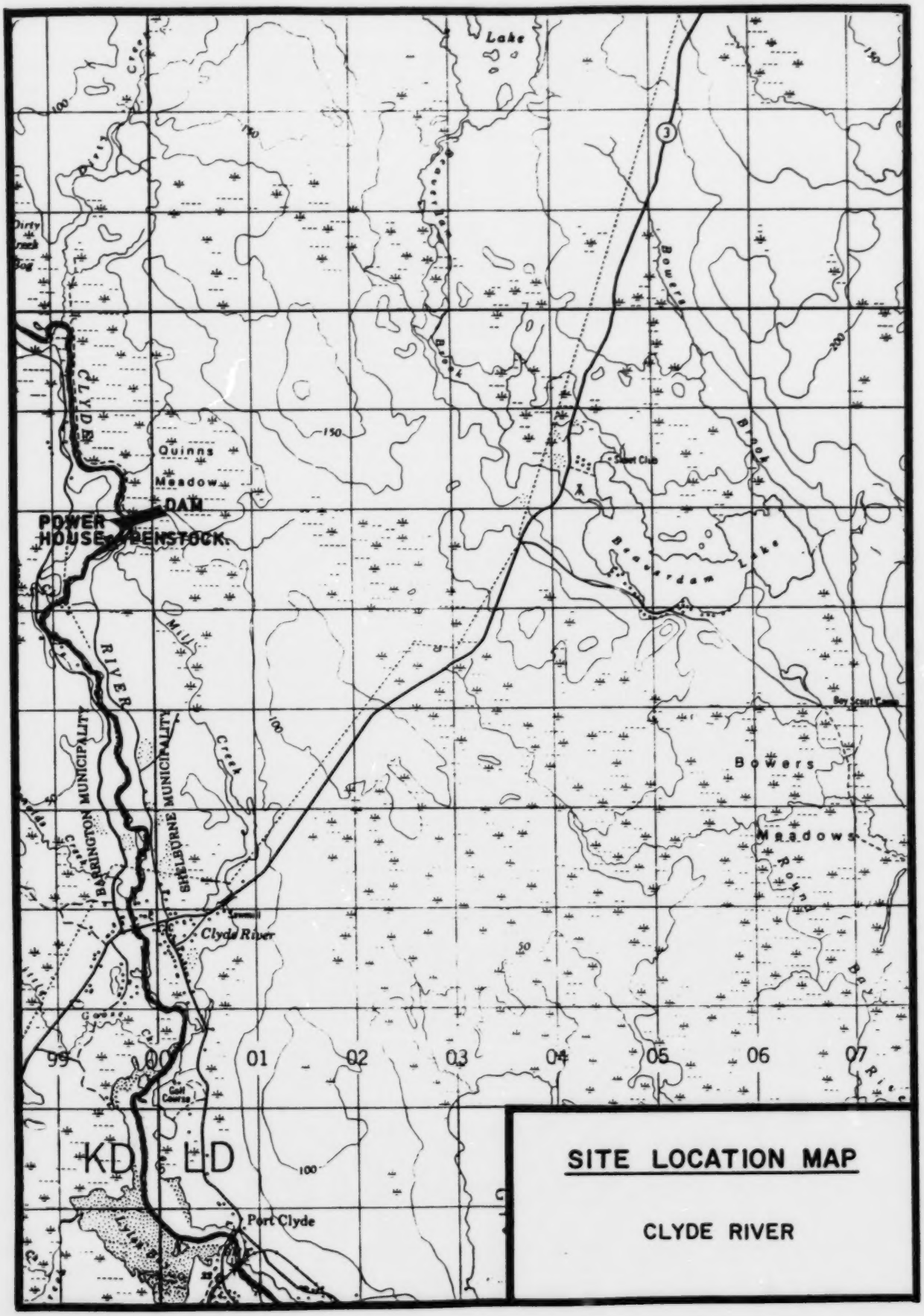
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1125917

ANNUAL BENEFIT : $ 1388460

BENEFIT/COST RATIO: 1.233182


Lake
CLYDE
Quinns
Meadow
DAM
POWER
HOUSE
PENSTOCK
RIVER
Mill
Creek
BARRINGTON MUNICIPALITY
SHELBURNE MUNICIPALITY
Clyde River
Bowers
Meadows
Brook
Boy Scout Camp
Golf Course
KD
LD
Port Clyde
99
00
01
02
03
04
05
06
07
SITE LOCATION MAP
CLYDE RIVER

WATER SHED : SALMON RIVER AT TRURO

No. 10

SITE NAME : S5

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	3.2 MW
PENSTOCK LENGTH	:	700 M.
DESIGN FLOW	:	12.2 M^3/S
PENSTOCK DIAMETER	:	2.289303 M.
RATED HEAD	:	30.5 M.
HEIGHT OF DAM	:	24.4 M.
TRANSMISSION LINE LENGTH	:	3 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	.5 KM.
FLOOD FLOW	:	242.3 M^3/S
DISTANCE TO TOWN	:	15 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 9293157

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
2011269	1160134	212800.1	755744.3	121150

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
641546.2	1364992	409497.6	42274.6	324303.1

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
1000400	477049.9	975036.9	407194.7

PROJECT COST: $ 9903393 COST PER KW: $ 3094.81

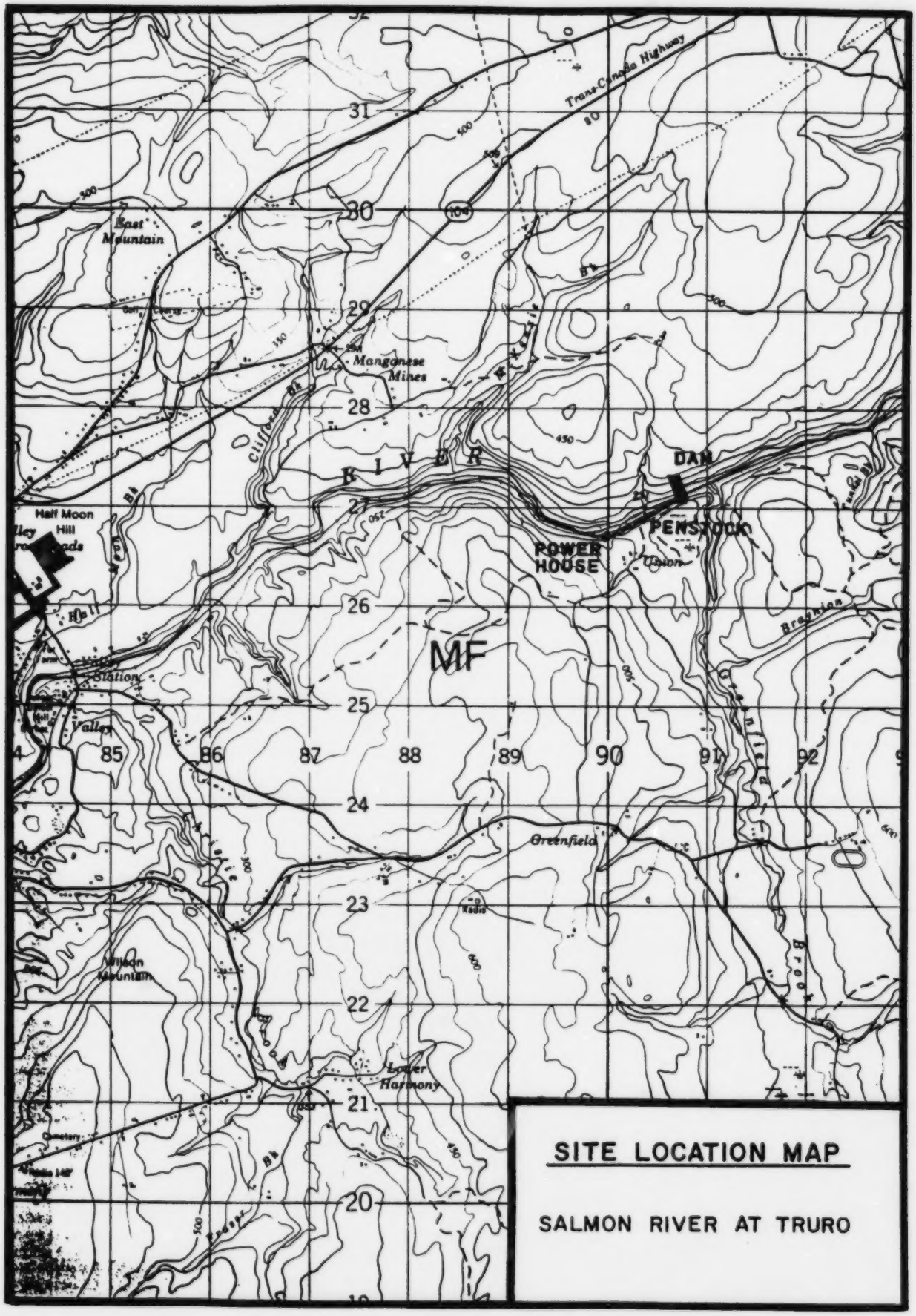
COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1138890

ANNUAL BENEFIT : $ 1401600

BENEFIT/COST RATIO: 1.230672


Trans-Canada Highway
East Mountain
Manganese Mines
Cliffbrook
RIVER
DAM
PENSTOCK
POWER HOUSE
Union
Half Moon Hill
Valley Station
Valley
MF
Greenfield
Brookfield
Wilson Mountain
Lower Harmony
Cemetery
SITE LOCATION MAP
SALMON RIVER AT TRURO

SHYDRO-PC VERSION 2.0 MARCH 1986
MONENCO MARITIMES LTD

WATER SHED : FISH RIVER

SITE NAME : F4

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	3.22 MW
PENSTOCK LENGTH	:	3900 M.
DESIGN FLOW	:	9.78 M^3/S
PENSTOCK DIAMETER	:	2.018583 M.
RATED HEAD	:	38 M.
HEIGHT OF DAM	:	4 M.
TRANSMISSION LINE LENGTH	:	13 KM.
LENGTH OF DAM	:	250 M.
ACCESS ROAD LENGTH	:	13 KM.
FLOOD FLOW	:	186 M^3/S
DISTANCE TO TOWN	:	30 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	30 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 9848977

COST ESTIMATE SUMMARY ($)

DAM (CONCRETE)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
534025.6	SEE DAM	174402.6	3711908	93000

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
596626.7	1269419	380825.5	674228.1	745913.5

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
164000	495846.1	1382139	601217.9

PROJECT COST: $ 1.082355E+07 COST PER KW: $ 3361.351

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1244708

ANNUAL BENEFIT : $ 1410360

BENEFIT/COST RATIO: 1.133085

WATER SHED : LISCOMB AT BIG STILLWATER

SITE NAME : L1

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	: 6.62 MW
PENSTOCK LENGTH	: 3500 M.
DESIGN FLOW	: 18.6 M^3/S
PENSTOCK DIAMETER	: 2.62866 M.
RATED HEAD	: 41.5 M.
HEIGHT OF DAM	: 8.5 M.
TRANSMISSION LINE LENGTH	: .75 KM.
LENGTH OF DAM	: 1350 M.
ACCESS ROAD LENGTH	: 1.5 KM.
FLOOD FLOW	: 296 M^3/S
DISTANCE TO TOWN	: 27 KM.
NO.OF UNITS	: 1
DISTANCE TO CONCRETE PLANT	: 27 KM.
USEFUL TURBINE FLOW RATIO	: .75
MAXIMUM TURBINE FLOW RATIO	: 1.5
LEAST COST	: $ 1.563658E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (STEEL)	UNWATERING
2830002	715026.3	311035.3	1.149454E+07	148000

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
1008090	2016180	601844.8	107555.5	54574.28

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
348500	995710.3	1942216	1146890

NOTE : SUBSTATION COST INCLUDED IN EQUIPMENT SUPPLY COST

PROJECT COST: $ 2.372017E+07 COST PER KW: $ 3583.107

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 2727819

ANNUAL BENEFIT : $ 2899560

BENEFIT/COST RATIO: 1.062959

WATER SHED : MOSER RIVER

SITE NAME : M2

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	2.34 MW
PENSTOCK LENGTH	:	2500 M.
DESIGN FLOW	:	8.93 M^3/S
PENSTOCK DIAMETER	:	2.001864 M.
RATED HEAD	:	30.5 M.
HEIGHT OF DAM	:	9.5 M.
TRANSMISSION LINE LENGTH	:	12.5 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	.4 KM.
FLOOD FLOW	:	164.4 M^3/S
DISTANCE TO TOWN	:	30 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	30 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 7189477

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
575563.8	479941.1	160699.4	2359700	82200
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
515316.5	1096418	328925.4	34970.83	647719.6
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
389500	462012.5	1057156	411979.3	

PROJECT COST: $ 8602102 COST PER KW: $ 3676.112

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 989241.8

ANNUAL BENEFIT : $ 1024920

BENEFIT/COST RATIO: 1.036066

WATER SHED : SALMON RIVER AT PORT DUFFERIN

SITE NAME : S2

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	1.7 MW
PENSTOCK LENGTH	:	1500 M.
DESIGN FLOW	:	6.5 M^3/S
PENSTOCK DIAMETER	:	1.74631 M.
RATED HEAD	:	30.5 M.
HEIGHT OF DAM	:	15.2 M.
TRANSMISSION LINE LENGTH	:	1 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	.3 KM.
FLOOD FLOW	:	129.8 M^3/S
DISTANCE TO TOWN	:	12 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	12 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 5532335

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1033690	525355.9	120745.2	1234984	64900
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
412038	876676.4	263003	27384.7	164592.9
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
623200	213940	755011	261593	

PROJECT COST: $ 6577114 COST PER KW: $ 3868.891

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 756368.1

ANNUAL BENEFIT : $ 744600

BENEFIT/COST RATIO: .9844413

WATER SHED : MUSHAMUSH RIVER

SITE NAME : M5

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	1.6 MW
PENSTOCK LENGTH	:	2000 M.
DESIGN FLOW	:	7.9 M^3/S
PENSTOCK DIAMETER	:	1.976848 M.
RATED HEAD	:	22.9 M.
HEIGHT OF DAM	:	7.6 M.
TRANSMISSION LINE LENGTH	:	.5 KM.
LENGTH OF DAM	:	225 M.
ACCESS ROAD LENGTH	:	1 KM.
FLOOD FLOW	:	158.4 M^3/S
DISTANCE TO TOWN	:	3 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 5648549

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
499687.1	414200.5	143917.1	1864145	79200
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
436585.7	928905.7	278671.7	76200	137912.7
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
311600	66592.18	818725.5	281944.4	

PROJECT COST: $ 6338287 COST PER KW: $ 3961.43

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 728903.1

ANNUAL BENEFIT : $ 700800

BENEFIT/COST RATIO: .9614448

WATER SHED : CLYDE RIVER

SITE NAME : U1

SITE DATA

INSTALLED CAPACITY	:	3.23 MW
PENSTOCK LENGTH	:	150 M.
DESIGN FLOW	:	24.6 M^3/S
PENSTOCK DIAMETER	:	3.418376 M.
RATED HEAD	:	15 M.
HEIGHT OF DAM	:	14 M.
TRANSMISSION LINE LENGTH	:	1.5 KM.
LENGTH OF DAM	:	1150 M.
ACCESS ROAD LENGTH	:	.5 KM.
FLOOD FLOW	:	375 M^3/S
DISTANCE TO TOWN	:	10 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	20 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1.115079E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (STEEL)	UNWATERING
4477528	1142830	400027.2	701358.6	187500

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
827623.3	1761326	528397.9	42274.6	254412.6

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
574000	538674.1	1132878	482268.4

PROJECT COST: $ 1.30513E+07 COST PER KW: $ 4040.65

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1500899

ANNUAL BENEFIT : $ 1414740

BENEFIT/COST RATIO: .9425949

WATER SHED : JORDAN RIVER

SITE NAME : J2

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	1.5 MW
PENSTOCK LENGTH	:	1300 M.
DESIGN FLOW	:	11.6 M^3/S
PENSTOCK DIAMETER	:	2.469616 M.
RATED HEAD	:	15.2 M.
HEIGHT OF DAM	:	3 M.
TRANSMISSION LINE LENGTH	:	10 KM.
LENGTH OF DAM	:	400 M.
ACCESS ROAD LENGTH	:	9 KM.
FLOOD FLOW	:	210.5 M^3/S
DISTANCE TO TOWN	:	20 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	20 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 5925697

COST ESTIMATE SUMMARY ($)

DAM (CONCRETE)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
543628.8	SEE DAM	203357.5	1514343	105250

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
481666.7	1024823	307446.8	493243.2	471668

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
123000	261602	821071.3	278316

PROJECT COST: $ 6629416 COST PER KW: $ 4419.611

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 762382.9

ANNUAL BENEFIT : $ 657000

BENEFIT/COST RATIO: .8617717

WATER SHED : LISCOMB AT YANKEE

SITE NAME : L2A

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	4.2 MW
PENSTOCK LENGTH	:	2300 M.
DESIGN FLOW	:	15.8 M^3/S
PENSTOCK DIAMETER	:	2.558533 M.
RATED HEAD	:	30.5 M.
HEIGHT OF DAM	:	13 M.
TRANSMISSION LINE LENGTH	:	6.3 KM.
LENGTH OF DAM	:	800 M.
ACCESS ROAD LENGTH	:	8 KM.
FLOOD FLOW	:	261.7 M^3/S
DISTANCE TO TOWN	:	15 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1.161461E+07

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (STEEL)	UNWATERING
2935496	825584.4	268558.7	7290317	130850

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
776063.8	1651200	495359.9	446253.3	524591.8

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
533000	570965.3	1570045	740415.1

PROJECT COST: $ 1.87587E+07 COST PER KW: $ 4466.357

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 2157251

ANNUAL BENEFIT : $ 1839600

BENEFIT/COST RATIO: .8527521

WATER SHED : BROAD RIVER

SITE NAME : B1

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	1.2 MW
PENSTOCK LENGTH	:	1200 M.
DESIGN FLOW	:	9.2 M^3/S
PENSTOCK DIAMETER	:	2.235328 M.
RATED HEAD	:	15.2 M.
HEIGHT OF DAM	:	6.1 M.
TRANSMISSION LINE LENGTH	:	2 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	.5 KM.
FLOOD FLOW	:	177.8 M^3/S
DISTANCE TO TOWN	:	20 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	20 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 4934841

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
359616.3	406856.7	165065.8	1264956	88900

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
412011.7	876620.5	262986.2	42274.6	174081.7

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
250100	229048.5	682039.3	214157.7

PROJECT COST: $ 5428715 COST PER KW: $ 4523.929

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 624302.3

ANNUAL BENEFIT : $ 525600

BENEFIT/COST RATIO: .8418999

WATER SHED : EAST FRENCH RIVER

No. 20

SITE NAME : F2

NOTE -PENSTOCK LENGTH EICEEDS 20+H

SITE DATA

INSTALLED CAPACITY	: 1.16 MW
PENSTOCK LENGTH	: 2800 M.
DESIGN FLOW	: 2.2 M^3/S
PENSTOCK DIAMETER	: .7946404 M.
RATED HEAD	: 61 M.
HEIGHT OF DAM	: 10 M.
TRANSMISSION LINE LENGTH	: .15 KM.
LENGTH OF DAM	: 400 M.
ACCESS ROAD LENGTH	: .4 KM.
FLOOD FLOW	: 69.5 M^3/S
DISTANCE TO TOWN	: 15 KM.
NO.OF UNITS	: 1
DISTANCE TO CONCRETE PLANT	: 20 KM.
USEFUL TURBINE FLOW RATIO	: .75
MAXIMUM TURBINE FLOW RATIO	: 1.5
LEAST COST	: $ 3405193

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1140191	252262.3	45543.71	1314547	34750

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
247390.5	526362.6	157908.8	34970.83	100692.4

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
410000	220562.4	636257.3	196565.9

PROJECT COST: $ 5318004 COST PER KW: $ 4584.487

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 611570.5

ANNUAL BENEFIT : $ 508080

BENEFIT/COST RATIO: .8307791

WATER SHED : JOHN AT WELSFORD

No. 21

SITE NAME : J1

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	2.22 MW
PENSTOCK LENGTH	:	650 M.
DESIGN FLOW	:	8.42 M^3/S
PENSTOCK DIAMETER	:	1.951878 M.
RATED HEAD	:	30.5 M.
HEIGHT OF DAM	:	27.5 M.
TRANSMISSION LINE LENGTH	:	20.5 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	.4 KM.
FLOOD FLOW	:	217.3 M^3/S
DISTANCE TO TOWN	:	15.3 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15.3 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 4885726

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
2403703	1155348	152415.4	598187.8	108650
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
496672.4	1056750	317024.9	34970.83	915208.8

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
1127500	510571.4	982589.1	374825.6

PROJECT COST: $ 1.023442E+07 COST PER KW: $ 4610.098

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1176958

ANNUAL BENEFIT : $ 972359.9

BENEFIT/COST RATIO: .8261636

WATER SHED : BARNEY'S RIVER No. 22

SITE NAME : F3

NOTE -PENSTOCK LENGTH EICEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	.85 MW
PENSTOCK LENGTH	:	1300 M.
DESIGN FLOW	:	6.5 M^3/S
PENSTOCK DIAMETER	:	1.925153 M.
RATED HEAD	:	15.2 M.
HEIGHT OF DAM	:	4.6 M.
TRANSMISSION LINE LENGTH	:	.65 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	.2 KM.
FLOOD FLOW	:	154.6 M^3/S
DISTANCE TO TOWN	:	20 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	25 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 3719359

COST ESTIMATE SUMMARY ($)

DAM (CONCRETE)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
535371.3	SEE DAM	120745.2	1179981	77300

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
323650.2	688617.5	206585.2	19401.29	101965.4

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
188600	178380.6	572362.4	161682.6

PROJECT COST: $ 4354643 COST PER KW: $ 5123.11

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 500784

ANNUAL BENEFIT : $ 372300

BENEFIT/COST RATIO: .7434344

WATER SHED : SALMON RIVER AT GUYSBOROUGH

SITE NAME : S1

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	: 1.66 MW
PENSTOCK LENGTH	: 3200 M.
DESIGN FLOW	: 0.390001 M^3/S
PENSTOCK DIAMETER	: 2.028669 M.
RATED HEAD	: 22.9 M.
HEIGHT OF DAM	: 13.7 M.
TRANSMISSION LINE LENGTH	: 3 KM.
LENGTH OF DAM	: 250 M.
ACCESS ROAD LENGTH	: 1 KM.
FLOOD FLOW	: 167.8 M^3/S
DISTANCE TO TOWN	: 18 KM.
NO.OF UNITS	: 1
DISTANCE TO CONCRETE PLANT	: 18 KM.
USEFUL TURBINE FLOW RATIO	: .75
MAXIMUN TURBINE FLOW RATIO	: 1.5
LEAST COST	: $ 5821664

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1102389	602394.9	151926.6	3060904	83900

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
447982.6	953154.4	285946.4	76200	242165.5

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
561700	373117.2	1225341	445571.9

PROJECT COST: $ 9612694 COST PER KW: $ 5790.78

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1105460

ANNUAL BENEFIT : $ 727080

BENEFIT/COST RATIO: .6577173

WATER SHED : CHIGANOIS RIVER

SITE NAME : C2

NOTE -PENSTOCK LENGTH EICEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	1.33 MW
PENSTOCK LENGTH	:	3400 M.
DESIGN FLOW	:	1.7 M^3/S
PENSTOCK DIAMETER	:	.8411329 M.
RATED HEAD	:	91.5 M.
HEIGHT OF DAM	:	30.5 M.
TRANSMISSION LINE LENGTH	:	8 KM.
LENGTH OF DAM	:	120 M.
ACCESS ROAD LENGTH	:	3 KM.
FLOOD FLOW	:	59.8 M^3/S
DISTANCE TO TOWN	:	12 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	12 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 3452446

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1776078	453367	36112.04	1351016	29900

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
236225.5	502607.4	150782.2	193868.9	386695.8

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
1250500	297805	839278.8	276738.1

PROJECT COST: $ 7780975 COST PER KW: $ 5850.357

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 894812.2

ANNUAL BENEFIT : $ 582540.1

BENEFIT/COST RATIO: .6510194

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MONENCO MARITIMES LTD

WATER SHED : HERBERT RIVER

SITE NAME : H3

SITE DATA

INSTALLED CAPACITY	:	1.6 MW
PENSTOCK LENGTH	:	300 M.
DESIGN FLOW	:	6 M^3/S
PENSTOCK DIAMETER	:	1.687227 M.
RATED HEAD	:	30.5 M.
HEIGHT OF DAM	:	22.9 M.
TRANSMISSION LINE LENGTH	:	14 KM.
LENGTH OF DAM	:	400 M.
ACCESS ROAD LENGTH	:	1.5 KM.
FLOOD FLOW	:	154 M^3/S
DISTANCE TO TOWN	:	30 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	30 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 5264034

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
3419706	780902.8	112352.9	238640.7	77000
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
394918	840251.1	252075.3	107555.5	614227.7
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
938900	1055287	931625.9	325497.9	

PROJECT COST: $ 1.008894E+07 COST PER KW: $ 6305.588

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1160228

ANNUAL BENEFIT : $ 700800

BENEFIT/COST RATIO: .6040192

WATER SHED : DEBERT RIVER

SITE NAME : D1

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	.94 MW
PENSTOCK LENGTH	:	2500 M.
DESIGN FLOW	:	1.7 M^3/S
PENSTOCK DIAMETER	:	.881434 M.
RATED HEAD	:	65.5 M.
HEIGHT OF DAM	:	22.9 M.
TRANSMISSION LINE LENGTH	:	2.5 KM.
LENGTH OF DAM	:	150 M.
ACCESS ROAD LENGTH	:	3 KM.
FLOOD FLOW	:	58.8 M^3/S
DISTANCE TO TOWN	:	15 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 2549101

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1414545	368506.7	36112.04	1040720	29400

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
208272.9	443133.9	132940.2	193868.9	177074.9

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
938900	298167.6	680226.6	200879.5

PROJECT COST: $ 6162749 COST PER KW: $ 6556.116

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 708716.2

ANNUAL BENEFIT : $ 411720

BENEFIT/COST RATIO: .5809378

WATER SHED : FRENCH RIVER

SITE NAME : F1

SITE DATA

INSTALLED CAPACITY	: .65 MW
PENSTOCK LENGTH	: 0 M.
DESIGN FLOW	: 3.51 M^3/S
PENSTOCK DIAMETER	: 1.407974 M.
RATED HEAD	: 21.4 M.
HEIGHT OF DAM	: 22.5 M.
TRANSMISSION LINE LENGTH	: 2.6 KM.
LENGTH OF DAM	: 150 M.
ACCESS ROAD LENGTH	: .65 KM.
FLOOD FLOW	: 99.8 M^3/S
DISTANCE TO TOWN	: 10 KM.
NO.OF UNITS	: 1
DISTANCE TO CONCRETE PLANT	: 15 KM.
USEFUL TURBINE FLOW RATIO	: .75
MAXIMUM TURBINE FLOW RATIO	: 1.5
LEAST COST	: $ 2445142

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1378729	550272.7	69346.48	0	49900
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
237970.1	506319.3	151895.8	52836.17	164578.2
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
922500	212001	473855.4	122570.1	

PROJECT COST: $ 4892774 COST PER KW: $ 7527.345

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 562669

ANNUAL BENEFIT : $ 284700

BENEFIT/COST RATIO: .5059813

WATER SHED : ECONOMY RIVER

SITE NAME : E1

SITE DATA

INSTALLED CAPACITY	:	2.35 MW
PENSTOCK LENGTH	:	1200 M.
DESIGN FLOW	:	2.97 M^3/S
PENSTOCK DIAMETER	:	1.069195 M.
RATED HEAD	:	91.5 M.
HEIGHT OF DAM	:	54.9 M.
TRANSMISSION LINE LENGTH	:	16 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	5 KM.
FLOOD FLOW	:	92.9 M^3/S
DISTANCE TO TOWN	:	35 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	35 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 5506101

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
7153511	970211.4	59666.26	605431.6	46450

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
351866.5	748652.3	224595.7	299281.2	774705.6

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
2250900	2352936	1582590	646063.8

PROJECT COST: $ 1.806686E+07 COST PER KW: $ 7688.027

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 2077689

ANNUAL BENEFIT : $ 1029300

BENEFIT/COST RATIO: .4954062

WATER SHED : POHQUET RIVER AT FORKS

SITE NAME : P4

SITE DATA

INSTALLED CAPACITY	: .57 MW
PENSTOCK LENGTH	: 0 M.
DESIGN FLOW	: 4.3 M^3/S
PENSTOCK DIAMETER	: 1.611773 M.
RATED HEAD	: 15.2 M.
HEIGHT OF DAM	: 16.2 M.
TRANSMISSION LINE LENGTH	: .2 KM.
LENGTH OF DAM	: 250 M.
ACCESS ROAD LENGTH	: .75 KM.
FLOOD FLOW	: 106.5 M^3/S
DISTANCE TO TOWN	: 15 KM.
NO.OF UNITS	: 1
DISTANCE TO CONCRETE PLANT	: 15 KM.
USEFUL TURBINE FLOW RATIO	: .75
MAXIMUM TURBINE FLOW RATIO	: 1.5
LEAST COST	: $ 2358957

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1376437	468415.5	83247.21	0	53250
P.HOUSE CIVIL	**EQUIP SUPPLY**	**EQUIP ERECTION**	**ACCESS ROAD**	**TRANS. LINE &SUBSTATION**
244678.1	520591.7	156177.5	59670.14	68393.69
FISHWAY	**CONTRACT OVERHEAD**	**ENG & OWNER**	**INT.DURING CONSTRUCT**	
664200	265490.8	440732	109435.2	

PROJECT COST: $ 4510719 COST PER KW: $ 7913.541

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 518732.7

ANNUAL BENEFIT : $ 249660

BENEFIT/COST RATIO: .4812884

WATER SHED : COUNTRY HARBOUR AT LAKE

SITE NAME : C1

NOTE - TRANSMISSION LINE LENGTH EXCEEDS 10*MW
NOTE -PENSTOCK LENGTH EXCEEDS 20*M

SITE DATA

INSTALLED CAPACITY	:	.43 MW
PENSTOCK LENGTH	:	1350 M.
DESIGN FLOW	:	3.26 M^3/S
PENSTOCK DIAMETER	:	1.430856 M.
RATED HEAD	:	15.2 M.
HEIGHT OF DAM	:	5.5 M.
TRANSMISSION LINE LENGTH	:	11 KM.
LENGTH OF DAM	:	75 M.
ACCESS ROAD LENGTH	:	.5 KM.
FLOOD FLOW	:	84 M^3/S
DISTANCE TO TOWN	:	35 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	35 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1658486

COST ESTIMATE SUMMARY ($)

DAM (CONCRETE)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
288912.5	SEE DAM	64884.93	910828.9	42000

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
200867.9	427378.6	128213.6	42274.6	469335.2

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
225500	205597.6	462426.5	107582.5

PROJECT COST: $ 3575803 COST PER KW: $ 8315.821

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 411217.3

ANNUAL BENEFIT : $ 188340

BENEFIT/COST RATIO: .458006

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MONENCO MARITIMES LTD

WATER SHED : MIDDLE AT ROCKLIN

SITE NAME : D2

NOTE - TRANSMISSION LINE LENGTH EXCEEDS 10*MW

SITE DATA

INSTALLED CAPACITY	:	.54 MW
PENSTOCK LENGTH	:	0 M.
DESIGN FLOW	:	3.71 M^3/S
PENSTOCK DIAMETER	:	1.49162 M.
RATED HEAD	:	16.8 M.
HEIGHT OF DAM	:	17.8 M.
TRANSMISSION LINE LENGTH	:	7 KM.
LENGTH OF DAM	:	200 M.
ACCESS ROAD LENGTH	:	.2 KM.
FLOOD FLOW	:	111.6 M^3/S
DISTANCE TO TOWN	:	8 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	10 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 2123583

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1280896	515582.8	72892.78	0	55800

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
227481.1	484002.3	145200.7	19401.29	324853.2

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
729800	145092.7	444993.2	109126.4

PROJECT COST: $ 4555123 COST PER KW: $ 8435.412

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 523839.1

ANNUAL BENEFIT : $ 236520

BENEFIT/COST RATIO: .4515127

WATER SHED : WEST BRANCH NORTH RIVER

SITE NAME : M1

NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	.37 MW
PENSTOCK LENGTH	:	1200 M.
DESIGN FLOW	:	.93 M^3/S
PENSTOCK DIAMETER	:	.7152041 M.
RATED HEAD	:	45.7 M.
HEIGHT OF DAM	:	19.8 M.
TRANSMISSION LINE LENGTH	:	2.3 KM.
LENGTH OF DAM	:	120 M.
ACCESS ROAD LENGTH	:	.1 KM.
FLOOD FLOW	:	38 M^3/S
DISTANCE TO TOWN	:	15 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 909601.3

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
938853.3	238278.9	20983.73	405872.4	19000

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
122998.1	261698.2	78509.45	10763.54	134308.9

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
811800	199001.9	412869.5	91354.36

PROJECT COST: $ 3746292 COST PER KW: $ 10125.11

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 430823.6

ANNUAL BENEFIT : $ 162060

BENEFIT/COST RATIO: .3761633

WATER SHED : WEST PICTOU

SITE NAME : P1

SITE DATA

INSTALLED CAPACITY	:	.61 MW
PENSTOCK LENGTH	:	550 M.
DESIGN FLOW	:	2.37 M^3/S
PENSTOCK DIAMETER	:	1.134267 M.
RATED HEAD	:	30 M.
HEIGHT OF DAM	:	23 M.
TRANSMISSION LINE LENGTH	:	.5 KM.
LENGTH OF DAM	:	300 M.
ACCESS ROAD LENGTH	:	.1 KM.
FLOOD FLOW	:	83.9 M^3/S
DISTANCE TO TOWN	:	10 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	20 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1989802

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
2656465	487666	48699.17	294318	41950

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
202239.7	430297.2	129089.2	10763.54	82318.65

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
943000	309841	639177.8	168243.2

PROJECT COST: $ 6444068 COST PER KW: $ 10564.05

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 741067.8

ANNUAL BENEFIT : $ 267180

BENEFIT/COST RATIO: .3605338

WATER SHED : FRENCH RIVER AT ANNAN

SITE NAME : F5

NOTE - TRANSMISSION LINE LENGTH EXCEEDS 10*MW
NOTE -PENSTOCK LENGTH EXCEEDS 20*H

SITE DATA

INSTALLED CAPACITY	:	.43 MW
PENSTOCK LENGTH	:	2500 M.
DESIGN FLOW	:	1.1 M^3/S
PENSTOCK DIAMETER	:	.768743 M.
RATED HEAD	:	45.7 M.
HEIGHT OF DAM	:	23 M.
TRANSMISSION LINE LENGTH	:	10 KM.
LENGTH OF DAM	:	150 M.
ACCESS ROAD LENGTH	:	.1 KM.
FLOOD FLOW	:	42.8 M^3/S
DISTANCE TO TOWN	:	15 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	15 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 1097577

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1423564	288479.2	24406.27	908406.6	21400

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
136642.3	290728.4	87218.51	10763.54	431335.2

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
943000	266057.7	623106.2	149857.7

PROJECT COST: $ 5604965 COST PER KW: $ 13034.8

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 644571

ANNUAL BENEFIT : $ 188340

BENEFIT/COST RATIO: .2921944

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MONENCO MARITIMES LTD

WATER SHED : FOLLY RIVER

No. 35

SITE NAME : Fó

SITE DATA

INSTALLED CAPACITY	:	.99 MW
PENSTOCK LENGTH	:	500 M.
DESIGN FLOW	:	1.9 M^3/S
PENSTOCK DIAMETER	:	.9338743 M.
RATED HEAD	:	61 M.
HEIGHT OF DAM	:	42.7 M.
TRANSMISSION LINE LENGTH	:	2.5 KM.
LENGTH OF DAM	:	300 M.
ACCESS ROAD LENGTH	:	.5 KM.
FLOOD FLOW	:	65.7 M^3/S
DISTANCE TO TOWN	:	20 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	20 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 2793273

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
6859914	617863.7	39914.09	220462.7	32850

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
221415	471095.7	141328.7	42274.6	179667.1

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
1750700	1150933	1188770	378583.2

PROJECT COST: $ 1.329577E+07 COST PER KW: $ 13430.07

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 1529014

ANNUAL BENEFIT : $ 433620.1

BENEFIT/COST RATIO: .2835948

WATER SHED : ECONOMY RIVER

SITE NAME : E2

SITE DATA

INSTALLED CAPACITY	:	2.74 MW
PENSTOCK LENGTH	:	700 M.
DESIGN FLOW	:	2.97 M^3/S
PENSTOCK DIAMETER	:	1.046436 M.
RATED HEAD	:	106.7 M.
HEIGHT OF DAM	:	85.4 M.
TRANSMISSION LINE LENGTH	:	16 KM.
LENGTH OF DAM	:	275 M.
ACCESS ROAD LENGTH	:	5 KM.
FLOOD FLOW	:	92.9 M^3/S
DISTANCE TO TOWN	:	35 KM.
NO.OF UNITS	:	1
DISTANCE TO CONCRETE PLANT	:	35 KM.
USEFUL TURBINE FLOW RATIO	:	.75
MAXIMUM TURBINE FLOW RATIO	:	1.5
LEAST COST	:	$ 6013192

COST ESTIMATE SUMMARY ($)

DAM (EARTHFILL)	SPILLWAY	INTAKE	PENSTOCK (FIBERGLASS)	UNWATERING
1.99019E+07	1343445	59666.26	345679.1	46450

P.HOUSE CIVIL	EQUIP SUPPLY	EQUIP ERECTION	ACCESS ROAD	TRANS. LINE &SUBSTATION
371275	789946.9	236984.1	299281.2	816769.5

FISHWAY	CONTRACT OVERHEAD	ENG & OWNER	INT.DURING CONSTRUCT
3501400	5368602	2974530	1355159

PROJECT COST: $ 3.74111E+07 COST PER KW: $ 13653.69

COST DATA

INTEREST RATE	: 10	REVENUE, $ PER MWH	: 100
O & M PERCENTAGE	: 1.5	CAPACITY FACTOR	: .5

ANNUAL COST : $ 4302276

ANNUAL BENEFIT : $ 1200120

BENEFIT/COST RATIO: .27895